An exploration of the strengths and weaknesses of using text messaging as a tool for self-report data collection in psychological research

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I declare that this thesis reports my original work, that no part has been previously accepted or presented for the award of any degree or diploma from any university, and that, to the best of my knowledge, no material published or written by any other person is included, except where due credit is given.

Erin Walsh

Extraordinary claims require extraordinary facial expressions.

- Sagan, via Terrett

Dedication

I dedicate this dissertation to my parents, Bernard and Kathy Walsh.

Acknowledgements

While reading this dissertation, spare a thought for Dr. Jay Brinker. Just over three years ago, she was faced with the backwards prose and scatterbrained thinking of an overenthusiastic novice. Jay's generous and witty critiques have provided clarity and order to what many would consider an unreasonable number of projects. Most importantly, she provided crucial criticism when it was needed, but never once dampened the sheer joy of conducting research.

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Mum, Dad, Snarfie, Langley, Cloudy, and Jay - I couldn't have PhDed without you.

Abstract

Short Message Service (SMS) has immense potential for self-report data collection because it makes use of mobile phones that people already own, and allows researchers to communicate with participants regardless of physical location. Though interest in the possibilities of SMS as a tool for psychological research is slowly growing, to date, there has been no structured investigation of how this potential may be applied in psychological research. The research within this thesis examined the feasibility of using SMS as a tool for self-report psychological research, focussing on its strengths and weaknesses as a research mode. Across fifteen studies, this was investigated using a mixture of literature review, meta-analysis, surveys, and interviews. Participant samples varied from the broad (general population, university students) to specific (the elderly, the deaf).

Strengths of SMS as a tool for self-report psychological research included growing interest in research community; positive perceptions of SMS as a research tool amongst potential sample; prompt responses and high response rate; suitability for frequent repeated sampling; and usefulness as a reminder prompt to support other modes of data collection. Weaknesses included a disconnect between stated willingness to participate and actual participation; response incompleteness; unsuitability for infrequent sampling; and some problems with psychometric equivalence in relation to other research modes like online or paper surveys.

This was the first structured evaluation of SMS as a tool for self-report data collection in psychological research. Conclusions are limited by somewhat arbitrary design choices (such as the psychological topic within surveys) made in the absence of guiding background literature. Future research can refine these choices and use the logic presented here to guide further investigation into how SMS performs with more varied samples, different psychological topics, and as part of different research designs.

This research has shown that while SMS has great potential as a tool for psychological self-report research, it has a number of weaknesses. Identifying these strengths and weaknesses, and some design choices which may mitigate the weaknesses, will open up possibilities for a wide range of future psychological research.

Presentations

The research in this thesis was presented at the following conferences.

Walsh, E., & Brinker, J. (2014) *As You Likert: cross-mode equivalence of administering lengthy self-report instruments via text message.* ACSPRI Social Science Methodology Conference 2014 (Sydney, Australia, 7th - 10th of December).

Walsh, E., Arundell, M., & Brinker J. (2014) *SMS4Deaf: Using SMS as a tool for psychological research with the Deaf community.* Australian and New Zealand Communication Association Conference (Melbourne, Australia, 8th-10th July).

Walsh, E., & Brinker, J. (2014) *Comparative engagement with text messaging across age groups.* Go8-C9 PhD Forum on Population Ageing (Sydney, Australia, 1st - 5th of December).

Walsh, E., & Brinker, J. (2013) *SMS or app?* International Society For The Study of Individual Differences (Barcelona, Spain, 22nd - 25th of July).

Walsh, E., & Brinker, J. (2013) *SMS - a boon for all the ages?* Australian Conference on Personality and Individual Differences (Melbourne, Australia, 22nd - 23rd November).

Walsh, E., & Brinker, J. (2013) *Is 160 the limit? Length of responses to open-ended questions in SMS in the context of other research modes.* Poster, International Society For The Study of Individual Differences (Barcelona, Spain, 22nd - 25th of July).

Publications

The following are citations for the published papers included in this thesis.

Walsh, E. I., & Brinker, J. K. (in press) Should participants be given a mobile phone, or use their own? Effects of novelty vs utility. *Telematics and Informatics*.

Walsh, E. I., & Brinker, J. K. (in press) Temporal considerations for self-report research using Short Message Service. *Journal of Media Psychology*.

Walsh, E. I., & Brinker, J. K. (in press) Short and sweet? Length and informative content of open-ended responses using SMS as a research mode. *Journal of Computer-Mediated Communication*.

Walsh, E. I., & Brinker, J. K. (2015). Delay between recruitment and participation impacts on pre-inclusion attrition. *The Quarterly Journal of Experimental Psychology*, *68*(4), 1-15.

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Preface

[...] the available evidence suggests that the impact of administration of mode on some of the better-documented response effects in survey measurement can be plausibly conceptualised on the basis of psychological considerations.

- Schwarz, Strack, Hippler, and Bishop (1991; p210)

The structure of this dissertation is slightly unusual. Studies are grouped into chapters, which outline the properties of SMS as a methodological tool for self-report research according to different stages of the research process (i.e. recruitment, administration, data evaluation, and analysis). Due to the methodological focus of this dissertation, the first chapter primarily consists of a structured literature review, rather than a more traditional theoretical overview.

Subsequent chapters consist of multiple studies, some of which will have been written for specific journals. These papers consequently focus on that journal's goals and scope, rather than the logical flow of the dissertation as a whole. To clarify the relationship between chapters, and the relevance of these constituent studies, each chapter will begin with a short introduction. Where possible, those papers which have been published are presented in their published format.

Table of contents

List of figures

List of tables

Chapter 1: Introduction

Self-report psychological research has stepped out of the laboratory and into people's mailboxes, telephones, and computers. Consequent strides forward in terms of research scalability, reach, ecological validity, and practical relevance have been hampered by potholes of diminished participant engagement, low response rates, and problems with construct validity. These complications have received substantial scholarly attention, but few have considered the possible remedy of further expanding the psychological researcher's methodological repertoire (Fahrenberg, Myrtek, Pawlik, & Perrez, 2007).

The technology available for psychological research has dramatically changed in the past decade (Dillman, Smyth, & Christian, 2014; Stern, Bilgen & Dillman, 2014), yet, reviews of self-report data collection tools, particularly the hardware available to support research, are rare and often dated (Ebner-Priemer & Kubiak, 2007). This may be because researchers tend to settle on a certain research approach or methodology, and are resistant to considering a change in approach (Campbell, Mutran, & Parker, 1986). Tellingly, Fahrenberg, Myrtek, Pawlik, and Perrez, (2007) note that participant willingness to use new data collection modes outstrips the willingness of psychological researchers to utilise it in their research. This is not a problem if the well-established data collection modes are adequate. For example, pen and paper is one of the historically oldest, and still one of the most widely used, methods for self-report data collection using surveys (Bolger, Davis, & Rafaeli, 2003; Dillman et al., 2014). However, a lack of consideration for methodological innovation is an issue when the current tools for data collection have shortcomings.

Ecological Momentary Assessment is a group of research methods typically involving the collection of data in a naturalistic setting, often through a repeated measures design. The defining characteristic of Ecological Momentary Assessment is that it occurs outside of laboratory conditions (Ebner-Priemer, Kubiak, & Pawlik, 2009; Fahrenberg, Myrtek, Pawlik, & Perrez, 2007). Though it can consist of either objective (e.g. physiological measures of things such as blood pressure) or self-report measures, the discussion here centres on self-report research. An example of a self-report Ecological Momentary Assessment design would be to ask participants to report their mood as they go about their daily lives.

Although Ecological Momentary Assessment offers unique, meaningful insight into the situational and temporal aspects of psychological processes, it has a reputation for being difficult and expensive to carry out (Bolger et al., 2003; Ebner-Priemer, Kubiak, & Pawlik, 2009). Examination of data collection methodology is potentially the key to the continued growth of Ecological Momentary Assessment research (Shiffman, Stone, & Hufford, 2008). The challenge faced by psychological researchers is to establish whether new self-report data collection modes could open up opportunities for data collected outside of the laboratory, and to assess if they have methodological limitations of their own, in particular help to bring down the methodological barriers to Ecological Momentary Assessment research. If this research mode is to support Ecological Momentary Assessment, it needs to be portable, accessible, convenient, and inexpensive. Paper diaries are portable, but have problems including inability to time stamp responses, and thus susceptibility to undetectable and undesirable retrospective responding (Bolger et al., 2003). Another popular option is digital devices, notably palm-top computers, pre-loaded with survey software (Shiffman et al., 2008). This method time stamps responses, but has its own limitations, such as the devices being expensive, and difficulties gaining physical access to participants in order to provide them with devices and training on how they should be used.

Another clear candidate for self-report hardware is the mobile telephone. With 96% global penetration (ITU, 2015), mobile telephones constitute one of the most exciting and potentially transformational self-report data collection modes available to psychology researchers. Essentially, much of the world's population are incidentally carrying self-report data collection devices with them in their daily lives.

Mobile phones (also known as cell phones) offer three avenues of communication with participants: Short Message Service (SMS), voice call, and applications (apps, typically available only on smart phones). All three can, and have been used to collect self-report information (e.g. Conner & Reid, 2012; Palen & Salzman, 2002; Tsai, et al., 2007). This dissertation focusses on SMS. Due to the possibility of automating sending, receiving, and aggregation of SMS, it is less time consuming and more scalable than voice calls: sending an SMS to 1 or 100 people requires the same amount of time and effort, but conducting 100 voice interviews entails far more effort than a single interview. As SMS functionality is native to all mobile telephones, it does not require participants to download a study-specific app. This avoids compatibility issues across smartphones (e.g. an Apple app will not run on an Android phone), and reaches participants who own more basic non-smart phones. It further avoids the need for an internet connection, which in turn circumvents the need for participants to be near a wi-fi connection (or use their own data plans, which may raise issues of quota overusage).

Thus far, we have established the need for methodologically focussed research, particularly to support Ecological Momentary Assessment. We have identified mobile telephones, and specifically SMS, as a viable candidate tool for self-report data collection. As a relative newcomer to psychological researcher's repertoire, the methodological properties of SMS are largely unknown. We next need to specify a disciplinary framework that can anchor investigation of the strengths and weaknesses of SMS as a tool for self-report data collection.

Though uptake of new research modes is slow, the rise of mixed-methods designs which use pre-existing modes in concert (Dillman et al., 2014) shows that researchers are starting to think about surmounting methodological limitations by way of the modes they choose to use. Before a limitation of a mode can be addressed, it needs to be identified. If the data collection mode has been used for some time, information can be gained from observing how the mode has performed in the past, through meta-analyses of methodological properties such as response rates (e.g. Cook, Heath, & Thompson, 2000; Fox, Crask, & Kim, 1988; Shih, 2008). However, the sheer variety of self-report psychological research designs makes it difficult to synthesise a coherent, generalizable view of factors impacting on the efficacy of SMS as used in a research context. A particular response rate for a particular study may be influenced by many factors, including but not limited to response mode, the incentive offered, or the duration or topic of the study (e.g. Heberlein & Baumgartner, 1978; Lee & Renzetti, 1990). Previous literature is also a challenging source of information if a data collection mode is new, as there is a limited pool of completed studies to draw from.

Though reflection on previous usage of a particular data collection mode is a useful first step, it needs to be followed by rigorous, methodologically-focussed investigation of the strengths and weaknesses of that mode. A conceptually coherent scientific background is required to guide such an investigation. Though at times theory will be borrowed from computer science, science communication, and sociology, this dissertation will ground its work primarily within the discipline of psychology. Psychology has a long, if intermittent, history of research into methodological considerations in self-report data collection. Paradigm shifts from face-to-face interviews to telephone interviews, and from paper surveys to online surveys, have been accompanied by peaks of interest in methodology (Dillman et al., 2014). Such research tends to focus on past performance via structured reviews or meta-analyses (e.g. Cook et al., 2000; Shih, 2008). There are some rare but heartening examples of methodologically-focussed investigations to evaluate particular properties of tools for data collection. For example, Lim, Sacks-Davis, Aitken, Hocking, and Hellard (2010) conducted a randomised controlled trial of the efficacy of three data collection tools (paper, online and SMS) for collecting sexual health information from young individuals.

Alongside the comparatively small self-report research methods literature, a parallel psychology literature explores the impact of other methodological concerns, such as question wording (e.g. Fisher, 1993; Warnecke et.al, 1997), question order effects (e.g. McFarland, 1981; Moore, 2002) and cross-language measurement invariance on how participants engage with and respond to research (e.g. Brislin, 1970). The underlying logic, design and analytical techniques of the broader research methods literature are applicable to the systematic investigation of specific properties of a research mode (Dillman et al., 2014; Schwarz, Strack, Hippler, & Bishop, 1991; Vandenberg & Lance, 2000). Following from this literature, a structure for investigating the properties of a data collection tool becomes clear: look back to see how the mode has been used, and then draw from the parallel psychological literature for theory, design, and analytical techniques to guide subsequent correlational and experimental investigation. This is the approach taken in this dissertation.

This thesis focusses on three (and later, four) key research questions, with a number of studies to support each question. Although the specific wording of the questions was decided upon at a relatively late stage, one study to address the essence of each question was planned in advance. Investigation began by exploring each question in the order presented here, however, these first studies soon fell out of sequence due to time differences in the ethical application and data collection processes. Further, they quickly revealed more knowledge gaps and additional research questions, which coupled with some unexpected opportunities for working with specific groups (such as the Canberra Deaf community), led to a proliferation of studies that were later grouped back under the four research questions.

The final chapter is a typical example of this. The single paper initially planned to address how SMS compared to other data collection modes was *SMS = Send My Survey: Short Message Service for Longitudinal Research.* After the initial literature review, it became clear that standards of measurement invariance were far stronger in the cross-language than cross-mode literatures. Because there was no room to build this consideration in to *Send My Survey*, *Applying cross-language principles to cross-mode measurement invariances* was developed. This required lengthy process of translating an English-language instrument which had previously worked well when administered via SMS (the Ruminative Thought Styles

Questionnaire) into a language that would provide a bilingual sample of reasonable size within the available undergraduate population (Chinese). By the time this process was complete, an unexpected opportunity to work with a collaborator with a subscription to self-report App software led to a third study being developed, run, and written-up. While conducting data collection for this third study, there was also scope to address some of the other four key research questions. In this way, a few initially planned studies became fifteen. In some cases, this approach led to substantial overlap in participant groups, and in some cases participants, as outlined in Appendix 4.

The four key research questions, forming the chapters of this thesis, are as follows.

1) How is SMS currently being used for research?

Understanding how SMS is being used for research will give context to the ensuing investigation, and highlight knowledge gaps. This question goes beyond psychology research because the way in which researchers use SMS in similar fields (such as epidemiology, sociology or medicine) could prove informative. It also does not specify self-report research. SMS is used for a highly diverse number of purposes in everyday life, and it stands to reason that it would also be useful for more than self-report data collection in research. Enumerating these alternative uses is informative for two reasons. First, it will allow examination of how common it is for researchers to use SMS specifically to collect self-report data, against how common it is for them to employ SMS in some way. Secondly, use of SMS for other purposes in research could provide useful information when it comes to self-report data collection. For example, the literature surrounding the use of SMS as a reminder to take medication or attend an appointment may have insights applicable to using SMS as a reminder prompt to complete a self-report questionnaire.

2) Are people able, ready and willing to become research participants using SMS?

The use of SMS as a self-report research mode requires successful recruitment of participants, and their subsequent engagement with SMS. It may be the case that participants are technologically unable or simply unwilling to participate in self-report psychological research using SMS. If this is true, questions surrounding completeness and validity of their responses become moot, because attempts to collect data via SMS would be fruitless. Alternatively, there may be some technological barriers, and scope to convince hesitant participants to provide self-report data via SMS. If this is true, the focus in following investigation should be on the techniques and research designs that may surmount these barriers and persuade participants to at least try participating in self-report data via SMS, before moving on to examining the resultant data quality. Finally, there may be no technological barriers, and participants may be willing to respond to self-report research questions using SMS. If this is true, then subsequent investigation can jumps straight to questions of data quality or validity. In this way, establishing ability, readiness and willingness to participate in research via SMS sets the research agenda for subsequent exploration of the properties of SMS as a tool for self-report psychological research.

3) How should a researcher design an SMS self-report study?

This research question draws from answers to questions (1) and (2), and begins to address the practicalities of conducting research via SMS. The question is first addressed with questions and methods the previous literature suggests may be effective, and a focus on how to work with participants: examining how SMS performs (and how this performance may be improved) in terms of recruitment, response rates and response behaviour. Then, the focus turns to the potential limits of SMS not previously explored in the literature, primarily how much information can be exchanged via SMS in a self-report research setting.

4) How does SMS compare with other tools for data collection?

This was initially planned as a subset of the third question, but results regarding participant perceptions of SMS emphasised the importance of situating SMS amongst other available research modes. It became clear that viewing the strengths and weaknesses of SMS in isolation is provides only part of the picture. The modern researcher can choose from many modes for collecting self-report data (Dillman, Smyth, & Christian, 2014). Why should a researcher consider SMS when they are already comfortable using online surveys, or automated telephone interviews? Having investigated the strengths and weaknesses of SMS in isolation, the final important question is therefore the strengths and weaknesses of SMS as a tool for data collection, relative to other research modes.

Across fifteen component studies, this dissertation constitutes the first systematic, methodologically-focussed investigation of the strengths and weaknesses of using SMS as a tool for self-report psychological research. The aim is to make the methodological properties of this relatively new research mode explicit, and situate it in the context of the other modes available to psychology researchers, in particular those seeking to conduct Ecological Momentary Assessment. To this end, the dissertation is structured around four questions that a prospective researcher is likely to ask when considering SMS as a tool for collecting data: ***How is SMS being used for research? Are people able, ready and willing to become research participants using SMS? How should a researcher design an SMS self-report study?*** And, finally, ***How does SMS compare with other tools for data collection?***

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Chapter 2: How is SMS currently being used for research?

The aim of this chapter is to provide context and highlight knowledge gaps in the use of SMS by researchers. Examination of all of the ways in which SMS is used reflects the diversity of its usage in everyday life, and anchors discussion of how often it is used for self-report data collection against how often it is used for other research purposes.

A systematic review of how SMS has been used in the health and psychology literature

Walsh, E.I, & Brinker, J.

Currently under review in *Review of General Psychology*.

Short Message Service (SMS, also known as text messaging) is a globally ubiquitous text-based communication method. Mirroring the swift uptake of SMS for everyday use in the general population, the health and psychology literature has begun to pay attention to the possibility of using it to communicate with clients and research participants. This article provides a starting point for those considering using SMS for their research or practise. 634 papers relating to SMS being used in health or psychology research or practise were found. Examination of these papers uncovered a yearly increase in the number of published studies using SMS to support research or clinical practise. There was a wide range of applications, including disease incidence tracking, self-report questionnaire administration, information distribution, and appointment attendance reminders. SMS tended to be used in a multimodal context to support other research methods and interventions. The majority of studies reviewed were within the domain of health, rather than psychology. There is a growing literature that uses SMS in a wide variety of ways, across many topics. This literature may inform future SMS usage. Psychology researchers in particular should be aware of the large amount of methodologically relevant studies in the health literature.

Short Message Service (SMS) is one of the most widely used data services world-wide (Kuntsche & Robert, 2009). The profound integration of SMS into people's daily lives is a rich field receiving extensive research attention (e.g. Battestini, Setlur, & Sohn, 2010; Leung, 2007; Ling, 2010). With a presence in everyday life and the literature, it is unsurprising that health and psychology practitioners have begun to pay attention to SMS, and the opportunities it provides for research, interventions, and support. Though constrained by its text-only nature and a somewhat strict character limit (typically 160 characters), SMS has a number of desirable properties. Its ubiquity can allow the researcher or clinician access to isolated populations (Suwamaru, 2012). Its scalability can make it appropriate for deployment to small or vast numbers of recipients (Kabadi, Mwanyika, & De Savigny, 2013), particularly given the potential to integrate and automate the process of sending and receiving SMS via programmed databases (Ngabo et al., 2012). Using SMS is convenient for both the sender, and the recipient (Leung, 2007; Liu, 2010).

Against the backdrop of rapid SMS uptake for everyday use in the general population (ACMA, 2013), and slow but steady uptake as a tool in the research literature (Conner & Reid, 2012), now is an opportune moment to investigate how psychology and health professionals and researchers are using SMS to develop a guide for future use. Condensing the literature into summary form will allow a birds-eye view of how SMS has been used. The intention is to provide a starting point for those considering using SMS for their research or practise, who may be unaware of the existing methodologically relevant literature. Though there is some overlap, the theoretical content of publications tends to follow topic or domain-specific groupings, for example, the distinction between the health and psychology literatures. Conversely, methodological issues transcend topic and domain. For example, an effective self-report methodology constructed for a particular topic within the health literature may be applicable to other health topics, or even for psychological topics, and vice versa. A timely cross-topic, cross-discipline summary of how SMS has been used alongside clearly grouped citations will afford health and psychology professionals with ideas for possible uses of SMS, and allow further reading into those uses across disciplinary boundaries. This systematic review will provide an overview of how SMS is being used in the health and psychology literature. The relative uptake of SMS in health and psychology domains will be contrasted and discussed.

Method

Sample

On their own or in combination, the key words *SMS, text, message, txt, mobile,* and *telephone* were entered as search terms the following databases: ScienceDirect, Ovid, PubMed, ProQuest, PsycInfo, and Google Scholar. The sample included dissertations and conference proceedings, so was not limited to peer-reviewed research. Some papers contained multiple relevant studies, so the counts and percentages discussed will refer to studies rather than papers. An initial pool of 1049 studies published prior to April 2014 were identified.

Criterion for study inclusion

As illustrated in Figure 1, studies were sorted under broad headings of preliminary research (where the use of SMS was discussed, but not employed), data collection, prompt to support other modes, or other health and psychological purposes. Studies on irrelevant topics such as everyday SMS usage, and SMS in advertising, were excluded. This resulted in a final sample of 643 studies.

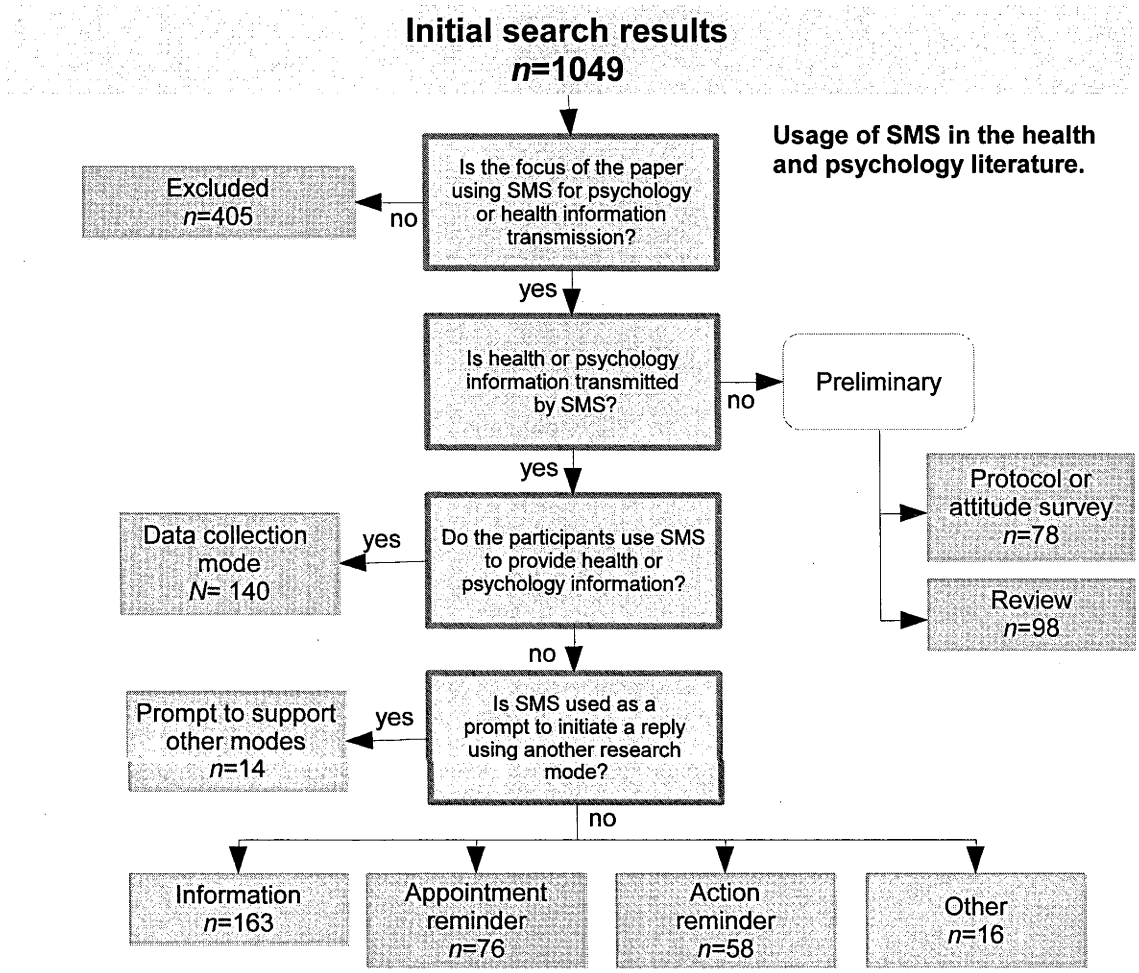

Figure 1. Flow chart indicating the meta-analysis review process

Results

The literature reflects a relatively low level of engagement with SMS in comparison to other more established tools, such as online surveys, but this will likely change. Since the first publication in 2000, the number of studies where SMS is used in the health and psychology literature has been steadily increasing over time (Table 1, Figure 2).

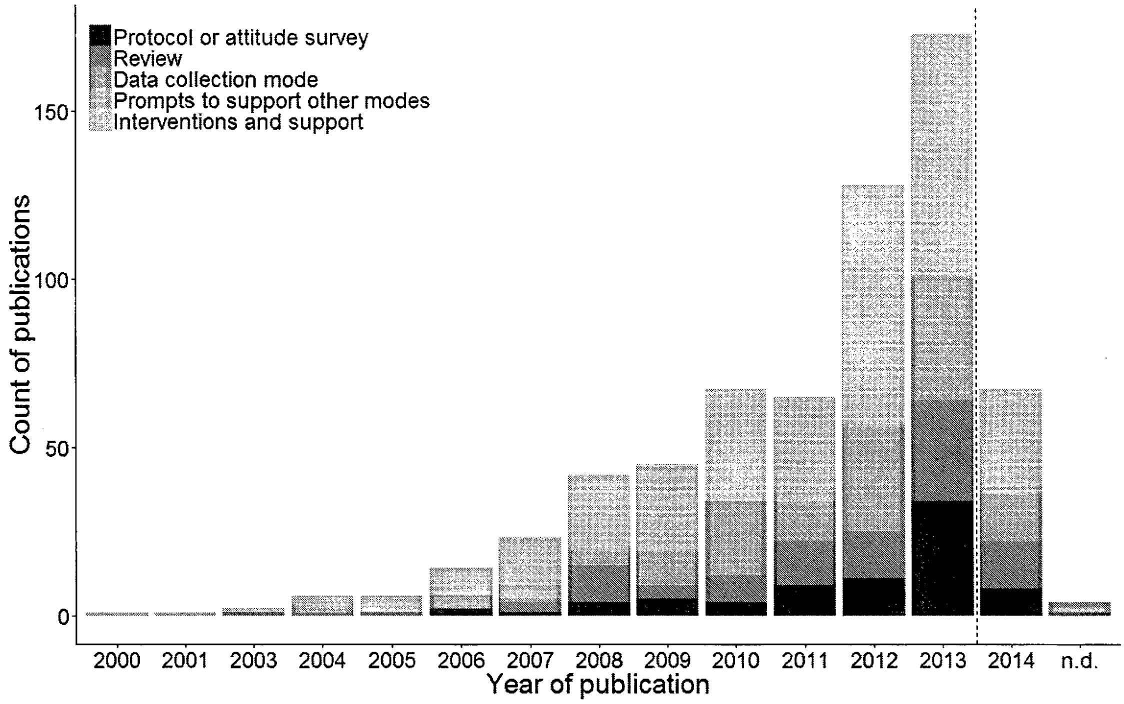

Figure 2. Studies relating to the usage of SMS for health and psychology purposes over time. Note that data for the 2014 column is only for the first half of the year; columns to the left of the dash line indicate all papers from that year were included.

Table 1. Count of studies relating to the usage of SMS for health and psychology purposes.

Year	Protocol or attitude survey	Review	Data collection mode	Prompts to support other modes	Interventions and support
2000	0	0	0	0	1
2001	0	0	0	0	1
2003	0	0	1	0	1
2004	0	0	2	2	2
2005	2	0	1	0	5
2006	1	0	4	0	8
2007	4	3	1	4	14
2008	5	11	4	1	22
2009	4	4	10	0	26
2010	9	8	22	0	33
2011	11	13	12	3	28
2012	34	14	31	1	71
2013	8	30	36	1	72
2014	0	14	14	2	29
n.d.		1	3	0	0

Note. Counts for 2014 does not include papers for the full year.

Preliminary papers. Across these preliminary papers and reviews, SMS is generally considered in terms of a wider topic (such as telehealth) or intervention (as part of a multi-modal framework), rather than as a single method of contact. This is in line with the growing use of mixed-mode research and multimodal interventions in the wider health and psychology literature, where multiple methods of contact are being used (Dillman, Smyth, & Christian, 2009).

Protocols and attitude surveys. There were 78 studies involving research exploring participant willingness to use SMS for communicating with clinicians or researchers, or outlining how such communication could be done, but did not actually use SMS. Most (88%) of the studies in this category focus on health, rather than psychology topics. For a list of constituent papers, see Appendix 2 Table 1.

Reviews. Meta-analyses and review papers were included in this category. Of the 98 studies in this category, the majority (81%) were focussed on health related topics rather than psychology topics. Thirty four percent were focussed specifically on the SMS modality itself, whilst the others covered SMS under the umbrella topics of using mobile phones including SMS (29%). The remaining studies mentioned using SMS incidentally whilst focussing on specific theoretical topics, or discussed it more broadly in terms of data collection methods. For a list of constituent papers, see Appendix 2 Table 2.

Data collection. Compared with the vast amount of research using paper, telephone, or online surveys, few studies use SMS as a mode for data collection. However, though the research is relatively sparse, there is considerable variety in the topics, purposes, and properties of health and psychology studies collecting data via

SMS. Of the 140 studies using SMS to collect data, most (81%) had a health rather than psychological focus. Four studies collected data via open calls, situations where researchers sent out a call for participation in an open-ended way to a population of unknown size, or in relation to incidence reporting, across a wide range of topics. Fourteen studies collected data via clinical reporting, where health clinics or organisation reported event-contingent information. A relatively new phenomenon (with the earliest literature being published in 2010), clinical reporting tended to involve disease surveillance and management in poorer countries, with a particular focus on malaria reporting and management. SMS was used as a method for self-report data collection in 122 studies. Topics included weight loss, disease management (asthma and diabetes), addiction management (smoking and alcohol use), sexual health, and stress and mood diaries. For a list of constituent papers, see Appendix 2 Table 3.

Prompt to support other modes. There were relatively few instances (n=14) where SMS was used as a prompt to support other modes of communication. Again, over half (66%) of the papers in this category had a health focus. SMS prompts were most commonly used in combination with online surveys (43% of studies had this combination), followed by postal surveys (36%), and apps (21%). In some instances, email was used in combination with SMS and reported under the category of 'electronic reminder'. For a list of constituent papers, see Appendix 2 Table 4.

Interventions and support. Publications using SMS for support and as part of interventions began around 2000, with a drastic increase between 2011 and 2012. Of the 313 papers in this category, the majority (88%) were focussed on health rather than psychology topics. As in the preliminary studies, SMS was often discussed as part of a multimodal framework. In this category, the most common non-research purpose for using SMS was to provide information to participants (52% of studies), a reminder for appointment attendance (46%) or reminders to carry out some action, such as to take medication (35%). Other uses included SMS being used in medication adherence reporting infrastructure (e.g. a blood glucose monitoring device that sends results to the clinician via SMS directly). For a list of constituent papers, see Appendix 2 Table 5.

Discussion

This overview of the health and psychology literature shows that the applications of SMS are widely varied. Against a backdrop of many other communication methods, such as post, email, or voice call, it is perhaps this versatility that underlies the growing literature surrounding using SMS in health and psychology domains. Over fourteen years, the number of publications involving SMS in some way has consistently increased. Its continued application in data collection, interventions, and support, covers the full gamut of health and psychology topics, from individual-level sensitive issues such as sexual health through to population-level disease tracking in rural areas. Accompanying these applications is a large number of preliminary research endeavours, and reviews, demonstrating an interest in the mechanics of how the usefulness of SMS may be further extended.

One persistent trend is a higher comparative volume of papers involving SMS in the health, rather than psychology domain. This may be an artefact of there simply being a greater volume of health-related research[1], or may reflect a different level of openness to new technologies in the literatures. Regardless, it indicates that a

[1] As a general example, at the time of writing, major journal databases had fewer journals categorised as psychology than health, i.e. Elsivier (99 psychology to 125 health) and Ovid (60 psychology to 114 health).

psychology clinician or researcher considering integrating SMS into their work would do well to look beyond the psychological literature, and search the health domain for ideas and evaluations of SMS applications. Another recurrent theme is SMS being used as a component in multimodal research, interventions, and support programs. SMS has been applied far more often as a reminder to complete a task in an interventions or support setting than in a research setting. Researchers considering using SMS as a prompt may learn much from the intervention and support literature.

SMS is a ubiquitous communication method that can contribute much to health and psychology domains. As it slowly gains traction as a tool in the clinical and research literature, reflecting on how it has been used so far can inform how it can be used in future. This systematic review has revealed remarkable versatility the role of SMS in the health and psychology literature, and provided citations across topics and disciplines for further reading. This is a valuable starting point for future researchers and professionals that may wish to investigate the potential further applications of SMS in the health and psychology domains.

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Chapter 3: Are people able, ready and willing to become research participants using SMS?

This chapter consists of five manuscripts. Chapter 2 has shown that SMS has been used for a wide range of purposes in the health and psychology literature. Though there are currently just 120 studies focussing on self-report data collection, the number of publications where SMS is used for research each year is increasing. This indicates a growing interest in the possibilities of SMS as a tool for data collection on the part of researchers. However, to be successful, a self-report research mode must be available and attractive to both researchers and their participants.

Ability to take part in research via SMS hinges largely on whether participants own a mobile telephone. If participants do not have access to a mobile telephone, it follows that a data collection mode requiring mobile telephones cannot be used. This raises questions regarding who may be expected to own mobile telephones, and whether the potential participant is capable of using SMS. As one major determinant of mobile telephone ownership and usage is age (Ling, 2008; Udine & Padova, 2002), the first paper in this chapter, *Assumptions of age and mobile handset type*, investigates mobile ownership in the general population, and what factors may help researchers estimate the likely mobile ownership in a given age group.

In cases where participants do not own a mobile phone, a researcher is faced with four options: not use SMS as a tool for their research; continue to use SMS and exclude non-mobile telephone owners from the study (e.g. Axén, Bergström, & Bodin, 2013; Devine et al., 2014); use a different data collection mode for non-mobile telephone owners (e.g. Macedo, Maher, Latimer, & McAuley, 2012); or provide a mobile telephone to participants for the purposes of participation (e.g. Reback, Ling, Shoptaw, & Rohde, 2010).

Assuming the researcher does not wish to take the first option, the second option is problematic if obtaining a representative sample is important, and non-mobile telephone owners systematically differ from mobile telephone owners. This may be the case if demographic factors influence mobile ownership, such as participant age (Ling, 2008), or geographical location (Haller, Sanci, Sawyer, Coffey, & Patton, 2006). These isues are addressed in more detail in the preceding papers, and in chapter 5 of this dissertation. The third option may be problematic due to cross-mode measurement variance, where responses are affected by the data collection tool in a way that systematically affects results. The fourth option, providing a mobile telephone for the purposes of participation, is a potential solution to the problem of participants not owning a mobile telephone. A researcher may want to do this to standardise the response experience across mobiles, or use an app in concert with SMS, it also solves the issue of participants not owning the necessary type of mobile telephone. Providing a mobile telephone would involve sending to the participant, or asking participants to collect a mobile telephone from the researcher, and typically then having them use the telephone in their own time, not in the researcher's presence. Sending the mobile to participants by courier or post risks damage or lost to the handset in transit, but may allow access to otherwise unreachable participants. Meeting participants in order to provide the handset is unfeasible for large samples and could be costly if a research assistant wage is involved, but can be beneficial if used as an opportunity to train the participant in the use of the mobile device for the purposes of research participation. The second paper in this chapter, *Should participants be given a mobile: Novelty vs Utility*, examines the feasibility of providing a mobile phone to participants for the purposes of participating in self-report research, where the participant meets the researcher to collect the mobile telephone.

The first part of this chapter focusses on the physical infrastructure underlying SMS capability. This can be thought of as participant's ability to participate, but it is not the whole story. Participants must also be *willing* to use SMS for the purposes of self-report research. The remaining papers within this chapter investigate how participants feel about the possibility of using SMS as a self-report data collection tool, and how this may affect participation behaviour. As with any other research mode or technology, it is possible that these feeling and behaviours will differ on the basis of demographic factors, most likely age (Ling, 2010). The first step is therefore to examine perceptions and response behaviours in general, and then to focus on pertinent demographic factors that may influence these perceptions. There is a multitude of factors and theoretical frameworks to describe participant perceptions of a research mode. This dissertation focusses on three meaningful factors that are particularly relevant to SMS: legitimacy, privacy, and convenience.

It is critical that participants perceive research as legitimate, and consequently be willing to engage with it (Koo & Skinner, 2005). Unfortunately the appeal of SMS as a communication tool has led to its use for less desirable purposes such as spam advertising. Many legitimate organisations are using SMS. For example, banks and financial institutions have begun to explore whether it can be used to integrate their communication with customers with their banking services (e.g. Amin & Ramayah, 2010; Nyeko, Moya, Kabaale, & Odongo, 2014). A recurrent theme within this literature exploring SMS for banking is whether the original informal nature of SMS communication, and the recent surge of using SMS for spam, diminish the perceived legitimacy of SMS usage for the purpose of banking. The same question is pertinent when considering the perceived legitimacy of SMS usage for the purpose of research. The third paper in this chapter, *Perceived legitimacy of SMS as a psychological research mode,* explores these issues.

Perceptions of privacy are associated with self-disclosure (Joinson, Reips, Buchanan & Schofield, 2010). The more private a situation is perceived, the greater the self-disclosure. If participants are asked to disclose personal information for research purposes, the perceived privacy of SMS will influence participants' desire to take part. There is a large literature regarding perceptions of everyday SMS usage (e.g. Broaddus & Dickson-Gomez, 2013; Häkkilä & Chatfield, 2005a, 2005b), and its use as a support for clinical interventions (e.g. Curioso et al., 2009; Kunutsor et al., 2010; Rodrigues et al., 2012). There is some literature examining whether privacy could be a barrier to participation in self-report research using SMS (e.g. Ranney et al., 2014), and some research using SMS to collect data has asked participants to report on their perceptions of SMS privacy (e.g. Walsh & Brinker, 2012). However, there is no evidence to suggest that discussions regarding perceptions of privacy for particular research projects necessarily translate to perceptions of SMS as a research tool in general (or, conversely, that they do not).

The convenience of SMS is one of the major reasons for its global popularity (Leung, 2007; Liu, 2010). Communicating with participants in a way they find convenient can reduce the perceived respondent burden, and consequently may improve response behaviour (Sharp & Frankel, 1983). This general perception of SMS as convenient may translate to perceptions of how convenient it would be to respond to researchers using SMS. For example, when SMS has been used to support clinical interventions, positive perceptions of convenience are often reported (e.g. Gram, Holtermann, Bültmann, Sjøgaard, & Søgaard, 2012; Kuntsche & Labhart, 2012; Mahatanankoon & O'Sullivan, 2008). The fourth paper, *Perceptions of privacy and convenience of SMS as a tool for self-report data collection*, investigates these issues with a sample drawn from the general population.

Examining perceptions of SMS as a tool for self-report data collection in the general population is useful in establishing general expectations. But, there are different demographic sectors that may engage with SMS in different ways. The most noteworthy demographic characteristic that can impact on technology engagement is age. Accordingly, the fifth paper *A tool for all the ages? SMS as a method for data collection with across a wide age range, an expectancy approach* examines attitudes toward SMS in general, and as a data collection tool, in the context of age.

Another demographic of particular interest are the Deaf and hearing impaired. Just as in the wider population, mobile telephone ownership and SMS usage is common among the Deaf (Pilling & Barrett, 2008). Just as SMS has facilitated communication between the Deaf and hearing communities (Power & Power, 2004), its application to research with the Deaf could allow for more inclusive data collection strategies. The sixth and final paper in this chapter, *SMS4Deaf – SMS as a mode for psychology research with the Deaf* examine

perceptions of SMS as a tool for data collection in the Australian Deaf community.

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Assumptions of age and mobile handset type

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Original

Assumptions of age and mobile handset type

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E.I. Walsh, J.K. Brinker, Assumptions of age and mobile handset type. Gerontechnology 2014;12(3):169-173; doi:10.4017/gt.2014.12.3.005.00 As mobile handsets become more sophisticated, they are capable of supporting increasingly sophisticated applications and software which can be used for mobile telephone based interventions, treatment, research and telecare. Though it is generally accepted that older individuals will own less sophisticated handsets, this brief study assesses age-associated factors relating to the type of mobile handset (cell phone, web phone, or smart phone) in more detail. Three hundred and twenty six Australian participants aged between 5 and 79 reported their age at first mobile purchase, and who initiated and made the purchase. Mobile handset type was significantly associated with both age and current everyday usage. It was concluded that current age, rather than age at time of purchase, was a simple and sufficient indicator of current phone handset type.

Keywords: aging, mobile telephone, short message service

Mobile telephones are increasingly being used in health and psychology settings, such as reminders to increase attendance for medical and psychological appointments[1,2] as part of interventions and treatment (i.e.[3,4]), and as a tool used in psychological research (i.e.[5,6]). The sophistication of a mobile telephone's handset, including its computational power and software capabilities, defines the scope with which it can be used for interventions, treatment, research, and telecare. Basic cell phones are limited to voice calls and text messaging, while more modern smart phones support apps, internet browsing, and other multimedia capabilities that may enhance interventions or research. The specific applications of mobile technology in health and psychology settings change with the age of the client or patient. For example, heath care applications generally focus on education for young adult users[5,7] and telecare for elderly users[8,9].

The type of mobile handset individuals are likely to own also changes with age[10]. As mobile handset type dictates how mobile telephone technology may be used, understanding the relationship between mobile handset type and age could inform better targeting of mobile telephone-based interventions and research across different age groups. In general, older individuals tend to use their mobiles less, have older mobile handsets[10], and have access to less sophisticated mobile capabilities[11] than younger individuals. Chronological age is easily obtained as a matter of course in health and research settings, and is broadly helpful in guiding researchers and health practitioners' expectations of likely mobile handset type. However, it may be more informative to consider the age of first mobile purchase, and who had control over that purchase.

The point in life when individuals first had access to mobile technology contributes to their current usage[10], and whether they are likely to upgrade their mobile handset[12]. Younger individuals were exposed to relatively sophisticated mobile telephones early in life[13]. Older Australian individuals were initially exposed to more primitive mobile technology following the establishment of the first cellular network in 1987[14]. Though they have been party to the ensuing advancement of mobile technology, older individuals are less likely to upgrade their mobile handset than younger individuals[12], indicating that the older a person was when they obtained their first mobile phone, the more basic their current phone is likely to be.

Another consideration is who initiated and made the mobile purchase. Research with 10-11 year old children found that 80% said it was their idea to have their first mobile phone[15], though it is most often bought for them by their parents[16-18]. In this scenario, the type of mobile purchased may be at the parents' discretion, rather than the child's. For older adults, it is often their adult children who make the choice that their parents should have a mobile phone[21]. Here, the type of mobile purchased may be at the adult child's discretion, rather than the older parents'. In both cases, the initiator and purchaser of the mobile may dictate the type of mobile handset purchased. If this occurs, the relationship between age at purchase and the type of mobile handset may be affected.

This brief study examines whether age at first purchase, and the age-related factors surrounding that purchase, are more informative than current chronological age in predicting current mobile handset type. It then explores whether current handset type is associated with how much the mobile is used for basic communication (specifically, voice calls and SMS or text messages) as well as, whether it can be uniformly expected that younger participants will have smart phones and older participants will have cell phones. The first hypothesis is that the age at which participants obtained their first mobile phone will be correlated with their current mobile handset type. The second hypothesis is that the relationship between age of first mobile purchase and mobile handset type will be mediated either by who made the choice that a mobile should be purchased, or who purchased the mobile, or both.

Method

The ethical aspects of this research were approved by the Australian National University Human Research Ethics Committee.

Participants

The current study forms part of a larger investigation regarding the way in which age affects engagement with mobile telephones. Data for three, focussed studies was collected simultaneously from the same group of participants; the other two topics focussed on different aspects of how people perceive SMS, and its application as a tool for researchers.

Three hundred and twenty four (324) members of the general Australian public aged between 5 and 79 took part. Sixty two percent were female, and the majority (80%) owned at least one mobile phone. Participants were recruited via an online panel service, with representativeness across age groups ensured by specifying demographic quota (a minimum of fifty participants from each of the following age bands: 5-14, 15-29, 29-35, 36-49, and 50 or older). The panel service offered sampling from the general Australian population, though precise representativeness of the population as a whole is not known. Participants were offered small monetary compensation for their participation.

Materials and procedure

Participants completed an online self-report questionnaire[19] regarding the purchase of their first mobile phone, and current mobile phone usage.

The major outcome variable is categorical in nature (as one can own a cell, web, OR smart phone), whilst predictor variables may be continuous (i.e. age) or categorical (i.e. whether the self OR others purchased the mobile). Logistic regression allows analysis of both continuous and categorical variables, and produces odds ratios which are useful in guiding interpretation. The relationship between the independent variable and dependent variable is shown by b, the slope of the relationship. A positive b indicates a positive relationship, a negative b a negative relationship, and the value of b indicates the magnitude of the relationship. The statistical significance of the relationship is indicated by a t statistic; its associated p value must be equal to or below 0.05 for the relationship to be considered significant. Overall model fit is denoted by pseudo R^2, which works on the same principal as R^2 values used in ANOVA and other regression analyses, but account for the categorical nature of data within the logistic regression model. McFadden's Pseudo R^2 was used here due to its conceptual similarity to R^2-statistics used in ANOVA and other regression. Finally, likelihood ratio tests are used to compare logistic regression models, indicating whether one particular model fits the data significantly better than another. As with the slopes in the logistic regression model, significance is indicated by a p value equal to or below 0.05.

Results and discussion

The first hypothesis, that the age at which participants obtained their first mobile phone will be significantly associated with the type of their current mobile handset, was supported. The age at which a mobile phone was first purchased was significantly positively correlated with chronological age ($r=0.91$, $p<0.01$) showing the older a person is now, the older they were when they got their first mobile phone. Descriptively, participants currently using a cell phone obtained their first mobile phone at an average 32 years of age, those currently using a web phone at 28 years of age, and those currently using a smart phone at 20 years of age. The relationships between variables of interest, chronological age, and age at purchase, are pictured in Figure 1.

Logistic regression revealed that overall, participants were significantly more likely to own a smart phone than a cell phone ($b=3.105, t=8.20$, $p<0.001$, McFadden's Pseudo $R^2=0.083$). They were not significantly more or less likely to own a web phone than a cell phone ($b=-0.260$, $t=-0.473$, $p=0.635$). Age when the first mobile telephone was purchased was significantly associated with the type of mobile phone participants had, with an older age at first purchase significantly associated with a lower likelihood of currently owning a smart phone ($b=-0.066$, $t=5.43$, $p<0.001$), but not a web phone ($b=-0.0168$, $t=-1.01$, $p=0.308$) rather than cell phone. The transition in age from primarily purchasing smart

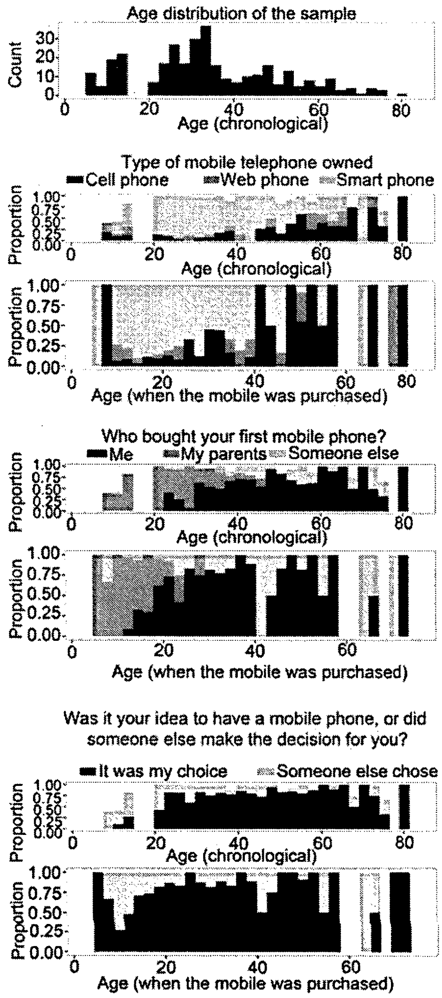

Figure 1. Age, mobile type, and factors impacting on first mobile purchase; white space indicates missing data, either due to non-response, or participants in that age band not owning a mobile telephone

phones to primarily purchasing cell phones was relatively sharp. With each increasing year of age at first purchase, the odds of buying a smart phone at first purchase decreased 0.93 fold with each year.

To establish whether age when a mobile phone was first obtained provided meaningful data beyond chronological age in predicting type of mobile handset, logistic model comparison by way of likelihood ratio tests was completed. The first model consisted or chronological age as a predictor of mobile handset type. The addition of age at first purchase as a predictor to this model significantly improved model fit, $\chi^2(2)=17.261$, $p<0.001$. Though multicollinearity confounds the usefulness of specific model coefficients in the model with both predictors, this suggests that an individual's age when purchasing their first mobile phone offers some information regarding mobile phone type, beyond just chronological age.

The second hypothesis was not supported. Even though both the initiator of first mobile purchase and who made the purchase were significantly associated with age at first purchase, they did not mediate the relationship between age of first mobile purchase and current mobile handset type. Overall, 76% of respondents felt they, rather than someone else, initiated the purchase of their first mobile phone. Twenty per cent of those who initiated the purchase themselves currently own a cell phone (rather than a smart or web phone), in comparison to 13% of those who felt the decision was made by others.

Age at purchase significantly predicted whether it was the self or someone else who initiated the purchase (McFadden's Pseudo $R^2=0.033$; $b=-0.042$, $t=-2.929$). However the initiator of the purchase did not mediate the relationship between age at purchase and current mobile handset type, as coefficients regarding the association between age at purchase and the likelihood of first obtaining a smart phone ($b=-0.066$, $t=-5.31$, $p<0.001$) or a web phone ($b=-0.0166$, $t=-1.01$, $p=0.319$) rather than cell phone, were unchanged by the addition of purchase initiator into the model (McFadden's Pseudo $R^2=0.08$).

Overall, 51% of participants bought their first mobile phone themselves, while 39% had it bought for them by their parents. Only 10% had it bought for them by someone else, an aggregate category collapsed across purchases made by children, friends, work or partners due

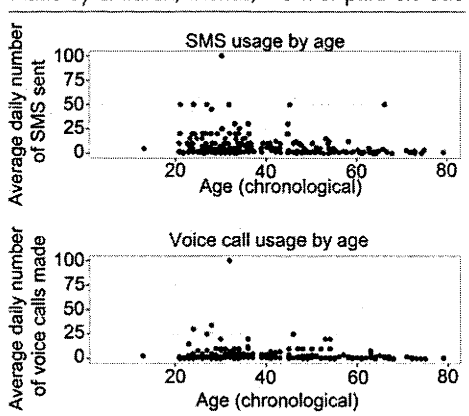

Figure 2. Average SMS (Short Message Service) and voice call usage by age

to low numbers in each category. Thirty two percent of those who bought their first mobile for themselves currently own a cell phone (rather than a smart or web phone), in comparison to 9% of those whose parents made the first purchase, and 38% of those who had the purchase made for them by someone else.

Age at purchase significantly predicted who bought the first mobile phone, with the odds that parents would make the purchase decreasing ($b=-0.27$, $t=-6.66$, $p<0.001$), and the odds that someone else would make the purchase increasing ($b=0.03$, $t=2.27$, $p=0.022$). Odds ratios indicate that with each passing year, the likelihood of parents buying the first mobile decreased 0.76 fold, and the likelihood that someone else would make the purchase increased 0.03 fold. The mean age at purchase where parents bought the mobile was lower (15 years) than where the participant bought their own mobile (27 years), which in turn was lower than where someone else bought the mobile (34 years). This is in line with the literature that children's first mobile is often bought by their parents[16,17,20], and suggests that to a lesser degree older adults are more likely than younger adults to have their first mobile bought for them by someone else. However the purchaser did not mediate the relationship between age at purchase and current mobile handset type, as coefficients reading the association between age at purchase and the likelihood of first obtaining a smart phone ($b=-0.065$, $t=-4.38$, $p<0.001$) or a web phone ($b=0.006$, $t= 0.300$, $p=0.764$) rather than cell phone, were unchanged by the addition of who made the purchase into the model (McFadden's Pseudo $R^2=0.094$).

Of those in the sample who owned a mobile telephone, most (73%) owned a smart phone, with 19% owning a cell phone and 8% owning a web phone. The commonality of smart phones is heartening for psychological and health interventions seeking to use mobile handsets for more sophisticated applications, such as apps or multimedia content. The relationship between phone type on basic communication (average self-reported daily usage of SMS and voice calls) was assessed with non-parametric Kruskal-Wallis tests, used in place of a one way ANOVA due to D'Agostino tests revealing significant positive skew in both number of voice calls, and number of SMS sent on an average day (skew=8.604, $z=11.41$, $p<0.001$; and skew=3.823, $z=8.37$, $p<0.001$ respectively). The skew was due to most participants only moderately using SMS and voice calls, but a sizeable portion of heavier users. The type of mobile handset was significantly related to the number of SMS sent per day ($\chi^2(2)=43.401$, $p<0.001$) and number of voice calls made per day ($\chi^2(2)=24.364$, $p<0.001$). Participants using a cell phone sent an average of two SMS and made an average of one voice call per day, in contrast to seven SMS and four voice calls by those using a web phone, and nine SMS and four voice calls by those using a smart phone. As handset type is associated with basic mobile usage behaviour, psychology and healthcare professionals may expect more participant engagement with mobile telephone based communication in smart phone users, than cell phone users.

Linear regression was used to examine whether age was associated with basic mobile usage, beyond the impact of mobile phone handset type. Once a single individual outlier (claiming to send 100 SMS and engage in 100 voice calls daily) was removed, current participant age was significantly negatively associated with average self-reported daily SMS usage ($b=-0.15$, $t=3.560$, $p<0.001$), but not when mobile type was added into the model ($b=0.01$, $t=0.48$, $p=0.65$). This suggests that, whilst younger individuals do use SMS more on a daily basis than older individuals, the relationship between mobile type and SMS usage overlaps considerably with the relationship between age and SMS usage. There was no significant association between age and average number of voice calls per day ($b=-0.0333$, $t=1.53$, $p=0.127$).

Conclusion

In summary, psychological and health researchers can look to more sophisticated applications with the expectation that large portions of the population will have access to smart phones, though there was support for the general assertion that older individuals are likely to own less sophisticated mobile handsets[10,11]. Particularly relevant to applications with the elderly, such as telecare, an increase in age was significantly associated with an increased likelihood of owning a cell phone, rather than a smart phone. This suggests that appointment reminders, interventions, treatment, and research targeted toward an older population should not assume smart phone ownership, and thus consider using communication techniques that do not rely on app installation or multimedia, but rather on basic functionality such as voice calls or SMS.

Whilst age first mobile purchase was significantly associated with whether the participant or someone else initiated the purchase of a mobile phone, and who made the purchase, this additional information did not significantly impact on the relationship between age and purchase and current mobile handset type. Though age at first purchase was a slightly better predictor of mobile handset more than chronological age, the strong positive correlation with chronological age indicates that either measure could viably be used. In a practical sense, chronological age is more available to researchers, as obtaining age at first mobile purchase requires additional questioning beyond basic demographic information. In conclusion, results indicate that future researchers seeking to use mobile telephones can make assumptions regarding the likely type of handset participants will own, on the basis of their chronological age.

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Should participants be given a mobile phone, or use their own? Effects of novelty vs utility

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Due to their ubiquity, mobile telephones may herald a great opportunity for ecological momentary assessment data collection. To access samples which do not own a mobile, or do not own a mobile that supports the preferred mode of response (i.e. apps), researchers may wish to provide participants with an appropriate mobile telephone for the purposes of participation. This often involves replacing a phone already in use. This study investigated the impact of providing a mobile telephone to participants for the purposes of participating in research, comparing the response behaviour of participants using their own mobile telephone against those using one provided by the researcher. Using iPhone 3s, 179 undergraduate participants completed a six-item questionnaire, 20 times over two day via app or text message. The three experimental groups consisted of those using their own iPhone, those using their own SIM in a provided iPhone, and those using a provided SIM in a provided iPhone. Results suggest that researchers seeking to conduct self-report research using mobile phones should be aware that the choice to provide a mobile telephone to standardise participant response platforms can impact on response behaviour.

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1. Introduction

There are an estimated 96 mobile subscriptions per 100 people globally (International telecommunication union, 2014). Mobile technology offers an unprecedented method of bidirectional communication between practitioners, clients, researchers and participants, through text-only technologies like Short Message Service (SMS) available on all mobile telephones, and mobile software (apps) and internet connectivity offered by smartphones. The past few years have seen a proliferation of physical health (see Boulos, Brewer, Karimkhani, Buller, & Dellavalle, 2014; Joe & Demiris, 2013; Mars, 2013) and mental health (see Aggarwal, 2012; Proudfoot, 2013; Shingleton, Richards, & Thompson-Brenner, 2013) interventions centred around mobile technology. Researchers too are beginning to capitalize on mobile technology as a mode of self-report data collection in psychological research (see Kuntsche & Labhart, 2013). When using mobile telephones in this way, it may be necessary to provide participants with a mobile telephone, either because they do not have one, the mobile they do have might be unsuitable for participation, or the researcher wants to standardize the research experience.

If a potential participant does not have a mobile, researchers may ask them to borrow someone else's mobile for the purposes of participation (e.g. Lagerros, Sandin, Bexelius, Litton, & Löf, 2012), or switch to a different method of data collection (e.g. Macedo, Maher, Latimer, & McAuley, 2012). The most common approach is to exclude participants without mobiles from data collection, either by using mobile telephone number registries for initial contact and recruitment (e.g. Bexelius, Merk, Sandin, Ekman, Nyrén, et al., 2009; Chib et al., 2012; Gold et al., 2011; Lim et al., 2010), or excluding non-mobile owners after initial contact and screening (e.g. Axén, Bergström, & Bodin, 2013; Devine et al., 2014; Suffoletto, Kristan, Callaway, Kraemer, & Clark, 2011). Whilst this approach is generally tenable due to a relatively high saturation of mobile ownership worldwide, it can be problematic with specific populations, such as adults in rural or developing areas, and children.

There are few examples where adult participants in a developed country were given the option to borrow a mobile if they did not own one, or did not wish to use their own for the purposes of participation (e.g. Berkman, Dickenson, Falk, & Lieberman, 2011). Historically, participants in developing countries are unlikely to own mobile telephones, and so researchers have provided them one (e.g. Andreatta, Debpuur, Danquah, & Perosky, 2011; Lori, Munro, Boyd, & Andreatta, 2012). As global mobile penetration increases, and mobile ownership even in poorer areas is becoming more common, research with children has become the primary area where mobile telephones are given to participants. This is done by either providing a mobile directly to the child (e.g. Alfven, 2010; Bauer, de Niet, Timman, & Kordy, 2010; de Niet et al., 2012) or to the parent or caregiver (e.g. Broderick et al., 2012; Chen, Chin, Greenberg, Johnstone, & McGuinness, 2012; Kazi, Murtaza, Khoja, & Ali, 2014). This approach may facilitate data collection, but purchasing mobile telephones (particularly smartphones) can be costly, and requires personal contact with the participant to hand over the mobile telephone. The cost and need to physically meet participant's means lending mobile handsets may not be viable for large scale studies.

The ubiquity of mobile phones has shifted the issue from whether participants have mobile telephones to the type of mobile telephones they have. In Australia, there are 130 mobile phones per 100 citizens (ACMA, 2011), 64% of which are smartphones (ThinkInsights, 2014). Though almost all mobile telephones support SMS, it is considerably more difficult to type an SMS response using the multi-press numeric keyboard system of a cell phone than the alphanumeric touchscreen of a smartphone. Further, cell phones do not support apps, mobile telephone specific software common on smartphones. A researcher may need to provide a smartphone to a cell phone user for the purposes of data collection (e.g. as in Irvine et al., 2012). However, even where there is high smartphone penetration, a researcher seeking to use a particular app may still have difficulties depending on the type of application they wish to use.

Whilst SMS works across different mobile brands and phone platforms, apps commonly have compatibility with a particular operating system (e.g. Android or iOS). Though there is an impetus toward cross-brand app development (Ribeiro & Da Silva, 2012), with some cross platform survey software (such as *QuickTapSurvey;* QuickTap Survey, 2014) the end user experience is often different due to differences in design and layout. Even with very similar mobile phones, people can have markedly different end user experiences in terms of ease of use and speed with which menu navigation can be achieved (Keijzers, Ouden, & Lu, 2008). In terms of psychological research, studies on paper and online surveys note that response behaviour is modified by implicit visual layout cues (Dillman, Smyth, & Christian, 2009; Smyth & Dillman, 2006), which are to some degree dictated by the size of a device.

In self-report research, size does matter. In paper surveys, a smaller page size is associated with lower response rates than larger page counterparts (Jansen, 1985). For online instruments, compact question spacing can make instruments more difficult to read and engage with (Smith, 1993). The spacing of questions also impacts on response length. In paper and online surveys, larger response areas prompt longer responses than smaller response areas (Dillman et al., 2009), and shorter and more clearly delineated response areas beget more precise responses (Fuchs, 2009). Whilst it can be expected a cell phone screen will be small (typically under 7cm across the diagonal), smartphone display sizes can differ drastically. There is also the mechanical difficulty of response composition. Aside from a general impact of mobile screen size on usability, with smaller screens being generally more difficult to use (Chae & Kim, 2004), touch screen key size is significantly associated with the speed and accuracy of use (Park & Han, 2010). The more difficult it is to type a response, the more burdensome responding becomes, and response burden is closely associated with response rates and attrition (Bolger, Davis, & Rafaeli, 2003).

Providing participants with a mobile phone for the duration of data collection to standardize the response experience is not an entirely new phenomenon. However, the mobile phone ownership landscape has drastically changed in recent years, and there are to date no structured investigations of the ways in which lending participants a mobile telephone (rather than having them use their own phone) may impact upon their response behaviour. One major issue is that, with the majority of the global population actively using a mobile telephone, lending a mobile telephone to a participant will likely involve replacing one already in use (as was the case in Irvine et al., 2012).

In this scenario, using the provided mobile is a novel experience for the participant. In general, novelty motivates people to engage with an experience (Berlyne, 1950), and indeed, novel modes of participation can increase engagement with research (Dillman, 2009). In a review of email survey response rates over time, Sheehan (2006) posited that the trend of participants providing more detailed, lengthy responses when email was a relatively new technology, relative to later years when email was more established, was due to the novelty of the technology. It may be that providing participants with a novel mobile phone might impact on responses, perhaps encouraging longer and more detailed responses by engaging participants by way of novelty. However, providing a mobile telephone to a participant raises a consideration beyond the handset itself.

For some phones the telephone number, contacts, and other data is associated with the SIM card inside the handset. The researcher must consider whether they provide both the handset and SIM card, or whether the participant ought to transfer their own SIM card into the new handset. If a participant can use their own SIM card in the novel handset, their friends, family and colleagues can still contact the same number whilst they participate in the study. By retaining their own SIM, they can use the provided handset as they would their own mobile. Alternately, if a participant is provided with a SIM, the new handset is only useful for the purposes of participation. Because the researchers are liable for the credit on a provided SIM, they are likely to limit its capacity for non-research purposes lest participants accrue unreasonable bills. A provided SIM is therefore less useful to participants than their own SIM. As perceived usefulness is associated with technology acceptance and usage (Venkatesh, Thong, & Xu, 2012) , it is possible that previously established habits, including keeping a mobile nearby, will transfer to the new handset only if it is useful (i.e. has the participant's SIM). It may be that the low utility of a handset and SIM provided by the researcher could result in response delays, as the participant is more likely to forget the handset.

Usage habits of general functionality may also come in to play. It is likely that SMS is already part of a participant's daily life, given high rates of SMS usage in the general population (ACMA, 2011). This means participants have prior experience with SMS, and will find it useful beyond responses sent to the researcher. Conversely, participants are unlikely to have a history of everyday usage of the particular survey app chosen by the researcher, and by its nature, the app will only be useful for the purposes of research participation. For these reasons, it is possible that the impact of novelty and utility of the handset on participant behaviour will be different depending on whether participants respond via app, or SMS. These two response methods should therefore be considered separately.

This study investigates the impact of providing a mobile telephone to participants for the purposes of participating in research, comparing the response behaviour of participants using their own mobile against those using one provided by the researcher. Both app and SMS data collection methods will be used to collect self-report data on the standardized response platform of an iPhone. Because provision of a mobile handset may provide a novel participation experience and that novelty may increase engagement, we propose a novelty hypothesis, whereby providing a mobile telephone should be associated with more complete responses. Specifically, more questions will be attempted by participants using a borrowed mobile phone than those using their own mobile phone. As a participant's own mobile phone is already useful, and integrated into their daily life, we propose a utility hypothesis, predicting that participants using their own mobile telephone will provide quicker responses than those using a borrowed mobile. To account for possible differences due to the specific response method, these hypotheses will be investigated separately for people responding via app and SMS. As important drivers of how people engage with information flow (Marathe & Sundar, 2011), the perceived privacy and convenience of participants using their own phone will be contrasted with those using a borrowed phone.

2. Materials and Methods

2.1 Participants

179 undergraduate students in Australia aged 17-55 (M=22), 58% female, participated in return for course credit. All but one already owned a mobile telephone, 65% owned an iPhone.

2.2 Materials

An initial online questionnaire consisted of personal demographic (such as age and gender), and mobile ownership demographic questions. This was followed by repeated administrations of the same six-item questionnaire on the topic of mental time travel. Each question required a numeric or short open-ended response. The first five questions were specified as mandatory, while the sixth was optional. Those responding via app did so via *iSurvey* (iSurvey, 2014). Those responding via SMS replied using their own phone plans, or if using a SIM provided by the researcher, a pre-paid Lebara mobile plan. Participants borrowing a phone were given an iPhone 3 and charger for the duration of participation. A final exit questionnaire asked about participant's perceptions of privacy and convenience while participating in the repeated measures portion. In the interests of space and conceptual simplicity, and in recognition that a wider Likert range is only informative with a large sample (Peabody, 1962), the valance rather than extremity of opinion of privacy and convenience was measured on a scale of poor, neutral and good.

2.3 Procedure

Participants were assigned to one of three conditions, described in Table 1.

Table 1. *Response conditions*

	Own SIM	Borrowed SIM
Own mobile	Low novelty High utility	
Borrowed mobile	High novelty High utility	High novelty Low utility

The decision to not utilise full random assignment was pragmatic. It is not possible to assign participants to owning or not owning an iPhone, and to give an iPhone owner another iPhone, or to give them a different SIM to put in their own phone would create bothersome logistical issues for the participants without guaranteeing improved data. Those who already owned an iPhone participated in the own SIM/own mobile condition. Those who did not own an iPhone were randomly assigned to either use own SIM/borrowed phone, or borrowed SIM/borrowed phone provided by the researchers. Due to a pragmatic element of a limited licensing timeframe for the iSurvey app, data collection began with all participants responding via app. Once the license expired, all subsequent participants responded via SMS. Upon signup, participants were not aware whether they would be responding via app or SMS, as the specific response mode was not mentioned in recruitment materials.

Participants met with the researcher for an initial meeting to complete online demographic surveys, and receive information regarding the repeated measures component. Those who did not own an iPhone were given an overview of how to operate the device, and were randomly assigned to the own-SIM/borrowed-SIM conditions. Participants responding via app were guided through process of app installation. All participants received a test prompt SMS, and made a practise attempt at the six-item questionnaire in the presence of the researcher to confirm correct contact details, and clarify the response process. Those responding via app had the six-item questionnaire pre-loaded, whilst those responding via SMS were sent the six-item questionnaire via SMS either during, or within 30 minutes of this meeting.

Participants received 20 SMS prompts on an individualised random schedule across two days (10 per day), prompting them to complete the six-item questionnaire. Those responding via SMS replied to the prompt with their answers, whilst those responding via app responded within *iSurvey*. Participants then attended a follow-up appointment, where they returned borrowed iPhones, uploaded results from the app, and completed an online questionnaire regarding their experiences of participation. Those in the SMS condition who were not on an unlimited plan were reimbursed for the cost of sending SMS associated with participation.

Incoming SMS data was manually parsed by the researcher, and combined with app responses downloaded from the app's online database. For subsequent analysis, response behaviour was broadly operationalised in terms of completeness and promptness. As the focus here is how complete response attempts are, analyses are only for responses where the person responded to a prompt and answered at least one question. A response was considered *partially complete* if at least one question was complete, *basically complete* if all five mandatory questions were completed, and *fully complete* if all six questions (the sixth being specified as optional in instructions) were completed. *Percentage completed* was calculated as the number of questions attempted, relative to a basic completion, such that if five questions were attempted, completion was considered 100%. To disentangle whether participants were responding as requested, or on their own schedule, responses were coded as to whether they were asked for (e.g. following a prompt), or extraneous (e.g. the preceding prompt had already received a response).

Response delay was operationalised as the number of minutes between a prompt, and the next response (in minutes). As is often the case in response time variables, response delay was bounded at one, as the shortest delay possible was coded as one minute, and significantly skewed. As this data shape was theoretically expected, the data was not transformed, but rather models were fit with a poisson distribution. Finally, to detect cutting and pasting rather than genuine response attempts, responses were screened for duplicates by calculating a similarity measure based on the Levenshtein edit distance (including capitalization) between each response and its immediate predecessor (within participants), with a distance of 1 indicating a duplicated response. To equate across different sample sizes across conditions, this was expressed as a percentage of total responses from that condition.

2.4 Condition imbalance

Analyses need to be considered in the context of the small sample size of participants in conditions where they respond via SMS using a borrowed phone. The initial recruitment plan, to have half of the participants using their own phone, and the other half borrowing, was hampered due to two factors. Firstly, upon signing up for the study, there were approximately half as many participants stating that they did not own an iPhone than those who did. This was then compounded by a disproportionate non-attendance rate of those who signed up on the understanding that they would borrow an iPhone, ultimately resulting in unbalanced, small cell sizes. As this pattern continued across two years of recruitment, it became clear that this was a persistent issue. Cook and Campbell (1979) note attrition at any point (even between recruitment and participation) can be informative. The initial difficulty in recruiting participants who did not own an iPhone is educative, as it suggests that, at least in an Australian university setting, a standardized response platform can be achieved without the need to lend mobile phones. To explore the disproportionately low attendance rate in those signed up to borrow iPhones, a follow-up questionnaire was distributed to all participants who did not attend their scheduled appointments. Participants were asked why they had not turned up to the appointment via multiple choice, tick-all-that-apply options (they forgot, attending was too inconvenient, or they decided to do another study), and open-ended response.

2.6 Analyses and power

This analysis consists of multilevel models, and contingency tables with χ^2 tests. Multilevel models allow analysis of repeated measures nested within individuals, and then comparison between individuals, in a single model. This allows slopes, intercepts, and associated error to be apportioned in a way that accounts for the structure of the data. The concept of "power" in the classical sense is problematic in the current multilevel models; particularly as the current data is expected to involve logistic and non-normal distributions. Accordingly, predictor significance will be discussed in terms of 95% confidence intervals, bootstrapped at 500 replicates, constructed around model parameters. The power statistic reported alongside the χ^2 tests were calculated using the "pwr" package for R (Champley, 2012), which essentially adjust Cramer's ϕ, for sample size and number of cells involved in the contingency table.

3. Results

3.1 Response behaviour

Analysis consisted of a series of logistic multilevel models, with ownership as a predictor of receipt of each outcome variable, nested by participant at level 1. The effect of using a borrowed mobile phone was examined in separate models for those responding via app, and those responding via SMS. The focus is not on the comparison between app and SMS, this division of data is to remove the potential confounding of response format on the relationship between novelty, utility and response behaviour. For participants who responded via app, models included comparison between those using their own mobile phone, and those using a borrowed mobile. For participants who responded via SMS, models included comparisons between three groups: own mobile, borrowed mobile / own SIM, and borrowed / borrowed SIM. The descriptive statistics of the outcome variables, by condition, are presented in Table 2. A summary of the model coefficients, and confidence intervals, are reported in Table 3.

Consistently significant level 2 intercepts across models indicate nesting by participant is meaningful for this data. There was no significant difference in *partial* or *basic* response rate between those using their own, or a borrowed, mobile phone (Table 3). There was a significant difference in the *full* response rate in those responding via app, but not those responding via SMS. Taking the exponent of the significant coefficient gives an odds ratio of 0.33, that is, participants using their own mobile were significantly and moderately less likely to provide a full response than those using a borrowed mobile.

Table 2. *Response completeness and delay summary*

		n	M % complete	*N* complete			% extraneous responses	Median response delay	Duplicate responses
				Basic	Full	Partia l			
App	Borrowed	39	83%	82%	75%	99%	12.20%	7 min.	1%
	Own	54	75%	74%	61%	98%	2.63%	3 min.	<1%
SMS									
BS	Borrowed	13	59%	24%	23%	82%	12%	7.5 min.	0
OS	Borrowed	11	75%	36%	36%	88%	3%	5 min.	<1%
	Own	62	74%	33%	29%	86%	4%	4 min.	2%

Note. M=mean, n= sample size. BS= borrowed SIM, OS= own SIM.

Table 3. *Multilevel model intercept and coefficients for models investigating the relationship between mobile ownership and response properties.*

	App		SMS
	Partial response rate		
Level 2	b(SD)=2.17, [1.94, 3.28]*		b(SD)=1.50, [1.38, 2.15]*
Level 1	b=-0.78, [-0.95, -1.98]*	Own mobile	b=0.82, [-0.002, 1.63]
		Borrowed mobile	b=1.01, [-0.23, 2.38]
	Basic response rate		
Level 2	b(SD)=2.05, [1.82, 3.04]*		b(SD)=3.33, [3.12, 4.70]
Level 1	b=-0.73, [-1.79, 0.03]	Own mobile	b=1.00, [-1.01, 4.20]
		Borrowed mobile	b=0.96, [-2.61, 4.56]
	Full response rate		
Level 2	b(SD)=2.11, [1.92, 2.87]*		b(SD)=3.17, [2.97, 4.45]*
Level 1	b=-1.10, [-2.21, -0.41]*	Own mobile	b=0.72, [-1.26, 3.72]
		Borrowed mobile	b=1.008,[-2.35, 4.39]
	Extraneous responses		
Level 2	b(SD)=1.47, [1.71, 3.34]*		
Level 1	b=-1.45, [-2.79, -0.79]*		
	Duplicate responses		
Level 2	b(SD)=1.13, [2.59, 7.44]*		
Level 1	b=-0.27, [-1.67, 1.24]		
	Response delay		
Level 2	b(SD)=0.91, [0.84, 1.07]*		b(SD)=.866, [.814, 1.04]*
Level 1	b=-0.38, [-0.40, -0.05]*	Own mobile	b=-.946, [-946, .137]
		Borrowed mobile	b=-.575, [-1.202, 0.105]

Note. Data from those responding via app, and SMS, are modelled separately. Base group for comparison in App models is own mobile, and the base group in SMS models is borrowed mobile/borrowed SIM. * indicates significance, denoted by 95% confidence intervals (in square brackets) not including zero.

Amongst those responding via app, mobile ownership was significantly associated with *extraneous responses*. Taking the exponent of the significant coefficient gives an odds ratio of 0.23, that is, participants using their own mobile were significantly and moderately less likely to provide an extraneous response than those using a borrowed mobile. Mobile ownership was not significantly associated with *duplicate responses*. Amongst those responding via SMS, there were too few extraneous and duplicate responses for statistical analysis.

Mobile ownership significantly impacted on *response delay* in those responding via app, but not those responding via SMS. Specifically, those using their own mobile responded significantly more quickly than those using a borrowed mobile.

3.2 Participant perceptions

Six chi-square tests were completed to explore the differences in participant perceptions of convenience and privacy. For each of convenience and privacy, a test was run amongst those using apps, comparing those using their own mobile or one provided by researchers (1). Among those using SMS, people using their own mobile were compared against those borrowing a mobile and using their own SIM (2), and those using both a borrowed mobile and a borrowed SIM (3). Count data is summarised in Table 4. Power was calculated as per Champely (2012), and is reported alongside Fishers's exact ρ.

Amongst participants responding via app, there were no significant differences in ratings of convenience or privacy (χ^2 =3.05, p=.205, power=.326, ρ=.169 and χ^2 =3.99, p=.067, power=.516, ρ=.061 respectively) between those using their own mobile telephones, and those using mobile phones provided by the researcher. Interpretation of perceptions of convenience and privacy is undermined by the small and unequal cell sizes in the SMS responses, resulting in low analytical power. There did not appear to be any significant differences in perceptions of convenience or privacy (χ^2 =1, p=.77, power=.13, ρ=.58 and χ^2 =.57, p=1, power=.09, ρ=.80 respectively) between those responding via SMS using their own or a borrowed iPhone. Neither were there any significant differences in terms of convenience or privacy (χ^2 =.98, p=1, power=.13, ρ=1 and χ^2 =.17, p=1, power=.07, ρ=1 respectively) between those using a borrowed iPhone with their own SIM or one provided. Together, these analyses tentatively indicate that participant perceptions regarding participation convenience and privacy generally do not differ depending on whether they are using their own, or a borrowed, mobile.

Table 4. *Counts of ratings of participation experience.*

		Convenience			Privacy		
Mode	Ownership	Poor	Neutral	Good	Poor	Neutral	Good
App	Own	1 (1%)	8 (15%)	43 (84%)	0 (0%)	7 (13%)	46 (87%)
	Borrowed	1 (1%)	11 (31%)	24 (68%)	0 (0%)	11 (31%)	25 (69%)
SMS	Own	4 (6%)	18 (32%)	36 (62%)	2 (4%)	11 (20%)	43 (76%)
	Borrowed (own SIM).	1 (9%)	2 (16%)	9 (75%)	0 (0%)	3 (25%)	9 (75%)
	Borrowed SIM (borrowed SIM).	0 (0%)	1 (12%)	8 (88%)	0 (0%)	3 (25%)	6 (75%)

3.3 Condition imbalance

Given that the sampling frame was non-respondents in the main study, the response rate was understandably low (n=17). With ages ranging from 18 to 53 (M=27) years, 41% of the respondents to the follow-up questionnaire were male. Six owned an iPhone, nine a different brand of smartphone, and two something other than a smartphone. Fifty eight percent forgot, 23% reported the appointment time was inconvenient, and 17% decided to do a different study. Reasons specific to borrowing an iPhone had significantly less endorsement, with only two people agreeing they were worried they'd break the iPhone, and one person not wanting the hassle of returning the iPhone.

4. Discussion

Response behaviour was influenced by whether participants used their own mobile, or a borrowed mobile telephone for participation. The novelty hypothesis, that participants using a borrowed phone would engage more with the research and thus provide more complete data, was supported amongst those responding via app, but not those responding via SMS. App respondents using a borrowed phone were more likely to go beyond the basic response requirements, providing significantly more full and extraneous responses than those using their own mobile. The lack of support for the hypotheses in the SMS respondents may be a result of the lower SMS response rate we found, meaning that there were fewer responses in total to differentiate between partial, basic and full responses. Alternately, it may be because all participants were familiar with SMS, so using SMS on an unfamiliar device was a less novel experience than using an unfamiliar app on an unfamiliar device. This second interpretation is supported by the significant interaction between whether participants responded via SMS or app, and using their own or a borrowed phone.

The utility hypothesis, suggesting that participants using their own mobile telephone should provide significantly quicker responses, was supported in those responding via app, but not those responding via SMS. However, unless the researcher is very concerned with response promptness, the statistical significance may not be practically meaningful, with the median response delay between groups being less than five minutes. The generally short response delays were consistent with participants keeping the borrowed phone with them, and being relatively vigilant for incoming prompts, rather than leaving the phone at home and forgetting to check them. Needing to keep the phone with them did not appear to be particularly burdensome, as across all groups, participants generally rated the convenience of participation as 'good'.

Participants using a borrowed SIM and handset, who likely had to keep both the researcher's and their own mobile with them, did not significantly differ from the other groups in terms of perceived convenience. Perceptions of privacy were unaffected by whether participants were using their own, or a borrowed mobile phone. This finding may have limited generalizability to the broader population, due to low statistical power, and due to the younger age of the sample. Younger adults tend to be less conscious of the privacy considerations of mobile telephone use than older adults (Ling, 2008).

At the time of data collection, iPhones were the dominant smartphone in Australia (representing 53% of smartphone sales; ACMA, 2012). One factor contributing to the difficulty in recruiting non-iPhone owners is therefore that a large portion of the undergraduate population the sample was drawn from likely already owned an iPhone. The disproportionate number of no-shows in those signed up to borrow a mobile phone was not explained by follow-up queries, with no indication of concerns specific to borrowing an iPhone reported. The technology acceptance model (Venkatesh, Thong, & Xu, 2012) notes that perceptions of usefulness are an important factor in technology uptake. It may be that potential participants who already have a mobile perceive the act of borrowing a mobile as not useful, reducing the behavioural intention to participate.

While undergraduates are a frequently used population in research, children are becoming the most common group being provided with mobile telephones for the purposes of participation. Research on adults is not directly applicable, as children engage with their mobile telephones in a distinct way (Lorente, 2002), tending to experiment more with the full capabilities of a phone rather than using just a few services (Inyang et al., 2010). Just as in the adult population, mobile ownership is becoming increasingly common in children (Davie, Panting, & Charlton, 2004), so the same issues associated with replacing a mobile phone already in use in the interests of standardization may well apply. Researchers working with children have a particular reason to consider providing a SIM card for participation (as in Shapiro et al., 2008); a child's SIM provides a direct method of contact that bypasses parental monitoring and control, and many parents may be concerned about providing their child's direct contact details to the researcher. Dunton, Liao, Intille, Spruijt-Metz and Pentz (2011) suggest providing a SIM to be used in the child's own mobile handset for the purposes of research only. Future research focussing on the effect of lending a mobile on the response behaviour of children should consider adding this condition to the design of the current study.

It should be noted that, for practical reasons, this study did not randomly assign who used their own, and who used a borrowed mobile telephone. It is possible that the differences between the own and borrowed conditions are related to characteristics of people who choose to own an iPhone versus those who do not. If this is the case, generalizability is limited to research situations where an iPhone is chosen as a standard platform. This possibility could be investigated in future research by assigning a different standard (such as an Android smartphone).

5. Conclusions

This study investigated the impact of providing a mobile telephone to participants for the purposes of participating in research. Results indicate that researchers seeking to conduct self-report research using mobile phones should be aware that the choice to provide a mobile telephone to standardise participant response platforms can be related to differential response behaviour. Lending a smartphone is costly in terms of initial outlay, and requires a physical meeting with participants to provide the phone, and regardless of the cause of the difficulty in recruiting participants when pre-existing phones are to be replaced for the purposes of participation further discourages lending phones. Given that providing a mobile phone or SIM had no significant effects on response behaviour, a researcher seeking to use SMS may consider abandoning standardisation in preference for maximising recruitment by allowing participants to use their own mobile phones. However, if the researcher seeks to use an app, standardisation of mobile telephones may be unavoidable, and can benefit data quality in terms of data completeness and response promptness.

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Perceived legitimacy of SMS as a psychological research mode

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This paper is currently under review in *Field Methods.*

Participant perceptions of a data collection mode's legitimacy is becoming increasingly important, as self-report data collection moves from interviews to methods using new technologies, where participants do not physically meet the researcher. Short Messaging Service (SMS) is a relative newcomer to self-report data collection. Understanding perceptions of the legitimacy of SMS may help to guide its application in a research context. Across two qualitative and one quantitative study (*N*=222), this paper developed a definition of 'legitimacy' specific to SMS as a self-report research mode, *A communication method is legitimate if: (1) You are confident that communications come from a trusted source (2) it is appropriate for the topic being discussed (3) you feel you could use it to provide a comprehensive and accurate answer.* This was applied it to gauge participant perceptions of the legitimacy of SMS as a tool for self-report research. Results indicated that participants feel the legitimacy of a research mode is important, and that the legitimacy of SMS is perceived as generally positive or neutral. However, SMS ranked poorly in legitimacy against other self-report research methods. These findings suggest researchers need to consider legitimacy in concert with other factors when considering SMS as a research methodology.

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Self-report surveys are fundamentally dependent on a sample of people deciding to sign up and engage with research (Groves, Cialdini, and Couper, 1992). Many factors impact on a person's willingness participate in research, such as a desire to help (Groves et al., 1992); a perceived capacity to participate (Schleifer, 1986); an incentive such as beneficial medical treatment (Wendler, Krohmal, Emanual, and Grady, 2008), or payment (Bentley, 2004); and the attributes of the researcher (Groves et al., 1992; Shavers, Lynch, and Burmeister, 2002).The mode which the researcher uses to communicate with participants can also impact on the recruitment and subsequent engagement of participants with the research (Dillman, Smyth, and Christian, 2009). Some modes may dissuade participation (e.g. expecting people in rural areas to travel for a face-to-face interview) whilst others may encourage it (e.g. postal surveys to rural areas). Once a participant is recruited, mode can also impact on responses, for example, an unstructured face-to-face interview is likely to produce more conversational response content than an open-ended written question embedded in a larger online survey.

During the transition from heavy reliance on telephone interviews to online surveys, much of the literature focussed on interviewer effects, and the impact of self- versus other- administration of questionnaires on self-disclosure (e.g. Bowling, 2005; Tourangeau and Smith, 1996), and the differences between paper and online survey administration. As the proliferation of online surveys shift the dominant self-report research paradigm to self- rather than other-administration, the impact of mode becomes more nuanced. Bowling (2005) notes that research modes differ in terms of anonymity, and argue that this impacts on participant engagement, which in turn impacts on response behaviour and data quality. As psychological research increasingly moves away from a scenario where participants physically meet the researcher, new tools for self-report research have emerged (Dillman et al., 2009).

One of the relatively new modes available to researchers is Short Message Service (SMS). Mobile telephone ownership is almost universal (Anhoj and Moldrup, 2009), and SMS usage is ubiquitous (ACMA, 2011; Kuntsche and Robert, 2009; Mackay and Weidlich, 2009). Though the technology has been available for over ten years, researchers have only recently begun to capitalise on the potential of SMS for self-report data, particularly in ambulatory assessment and repeated measures settings (Walsh and Brinker, under review). SMS allows bidirectional communication between researchers and participants regardless of participant location (Haller, Sanci, Sawyer, Coffey, and Patton, 2006). Outgoing messages can be scheduled cheaply via online bulk services (Steeh, Buskirk, and Callegaro, 2007), which automatically aggregate incoming messages, avoiding the cost and potential for error incumbent in manual data entry from modes such as paper responses (Johansen and Wedderkopp, 2010). Text messaging has an advantage over mobile applications ('apps') in that it is compatible with all mobile telephone handsets, while apps are often limited to particular smartphone operating systems. Despite calls for investigation focussing broadly on SMS as a response mode in general (Cocco and Tuzzi, 2012; Tomlinson et al., 2009), research so far has primarily regarded the applicability of SMS as a research mode for specific topics (e.g. Lim, Sacks-Davis, Aitken, Hocking, and Hellard, 2010) or specific demographics (e.g. Akamatsu, Mayer, and Farrelly, 2006). The current paper will be the first to examine participant perceptions of the legitimacy SMS as a tool for data collection in psychological research.

Legitimacy in general use refers to how something or someone stands in accordance with established rules, principles, or standards. Within the literature, legitimacy of a research mode has been conceptualised in a number of ways. One common theme is doubt or difficulties establishing the credentials of research, which can in turn can diminish the likelihood of participation in a study (Bowling, 2005). Problems with the legitimacy of a research mode stemming from fundraising or marketing masquerading as research are not new (Schleifer, 1986). To some degree, it is an issue for most research modes, but it is particularly problematic for SMS. Dubbed 'frugging' and 'sugging', many people receive unsolicited marketing spam via SMS that could easily be confused with genuine research (Nancarrow, Tinson, and Evans, 2004). Saturation of such messages may cause potential participants to be suspicious of research that uses SMS in some manner, or simply disregard genuine researcher contact, even if participants are initially contacted and recruited through trusted means.

Legitimacy can also be thought of in terms of the other uses of a mode. In the 1950s, it took some time for participants used to paper surveys to accept the legitimacy of research conducted via telephone (Dillman et al., 2009). Given that the SMS usage in everyday life is primarily social (Battestini, Setlur, and Sohn, 2010), perception of SMS as an informal method of communication may prove a barrier to participation, as its informality may be perceived as contradictory with the "seriousness" of research. Some, or all of these elements may constitute how participants evaluate the legitimacy of a research mode.

Because perceptions of the legitimacy of SMS as a tool for data collection may help to guide its application in a research context, it is worthwhile establishing a definition of 'legitimacy' based on participant evaluation of SMS. Across three studies, this paper develops such a definition, and investigates participant perceptions of the legitimacy of SMS as a tool for self-report research.

Study 1

Before the legitimacy of any given research mode can be discussed, an appropriate definition of legitimacy must be established. As the ultimate utility of such a definition is uncovering how participant perceptions of the legitimacy of a mode impact upon recruitment and response content, such a definition should draw upon participant's conceptualization of legitimacy. To this end, the aim of this study was to establish a working definition of the concepts of legitimacy as applied to using SMS as a tool for psychological research.

Participants

Eighteen members of the Australian general public aged 19-74 (M=36.88, SD=17.40), 78% female, were recruited via posters and online advertisements. No incentives were offered for participation.

Materials and procedure

As part of a larger project, participants underwent a semi-structured interview in person, or via telephone. The interview included questions regarding mobile phone ownership, usage, and attitudes, as well as questions focused on using SMS as a tool for communication in research. Questions about the legitimacy of SMS as a tool for research were phrased in terms of communication between a researcher and participant so could be interpreted to include both recruitment via SMS, and participation via SMS once initial contact had been made using a different research mode.

A grounded theory approach to qualitative analysis was applied to interview transcripts and focused on the content related to the legitimacy of SMS. This involved the primary researcher transcribing the interviews and establishing recurrent themes, and then two independent researchers counting the occurrences of the themes within the transcripts.

Results and discussion

The researcher and a colleague independently coded the data, in the interests of brevity percentages from the principal investigator (and kappa, with values approaching 0 indicating low inter-rater agreement, and values approaching 1 indicating high inter-rater agreement) are reported here. Three concepts emerged from qualitative analysis of responses regarding legitimacy: ability to convey nuance, formality of the mode, the inability to verify identification. Eleven percent of participants mentioned that SMS is a poor method for communicating nuanced responses, particularly emotional tone (kappa=1). This may impact on the perceived legitimacy of research where nuance is required in an answer:

> "In terms of legitimacy, it depends on what you're trying to communicate. If it's just short messages, and it's quite brief, that's good. But, if you're trying to compare nuances, I think it's pretty illegitimate unless you're using smiley faces. But even then, a lot gets lost. In terms of research, it depends on what you're looking at"

Thirty three percent participants interpreted the legitimacy of SMS as a communication tool in terms of informality (kappa = .9).

> "I would see text messaging as a rather more informal theme of communication. More like hints, information grabs, reminders, rather than more formal communication. For instance, you may be informed that your presence is required, that type of thing. No, I wouldn't see it as a particularly legitimate form of communication, as far as formal goes."

Issues of nuance and formality were often discussed in terms of the purpose or content of the information (*"it depends on what you're trying to communicate"*). These interpretations are therefore related to appropriateness of use. Finally, 22% of participants mentioned that legitimacy was tied to whether the identities of the SMS sender could be verified (kappa=1).

> "If you know who the texter is, then you feel that it's a worthwhile / legitimate text. It's not a scam, or somebody who you don't know trying to contact or scam you."

Based on these initial responses, a working definition of legitimacy was developed as follows: *A communication method is legitimate if: (1) You are confident that communications come from a trusted source (2) it is appropriate for the topic being discussed*

An unexpected theme emerged during discussion with participants during the interviews. Several participants anchored their perceptions of SMS against other alternative methods of communication, such as email or voice call. This suggests that further investigation should explore perceptions of SMS in a comparative rather than absolute context. There was no association between age and perception of legitimacy, that is, older participants did not provide systematically different responses from younger participants. In summary, this study clarified the concept of legitimacy as applied to participant perceptions of SMS as a tool for psychological research with a sample sourced from the general population. Results suggested that it should be discussed in a comparative context.

Study 2

The aim of this study was to evaluate, and if needed improve, the working definition of the concept of legitimacy in a sample who had experience participating in research via SMS.

Participants

Sixty undergraduate students aged 17-28 (M=18.9, SD=1.96), 60% female, participated in return for a course credit incentive.

Materials and procedure

Participants completed a paper questionnaire upon exit from a larger study, wherein they completed a short self-report survey via SMS. Without provision of a definition of 'legitimacy', they were asked to rank the SMS, online, email and postal surveys in order of legitimacy in terms of communication between researchers and participants, and to reflect on the legitimacy of the SMS in an open-ended question. Using a grounded theory approach for qualitative analysis, the researcher extracted themes from the open-ended responses regarding the legitimacy of SMS as a tool for research. The adequacy of the working definition of legitimacy was then evaluated against these themes.

Results and discussion

Upon compilation of open-ended reflections of legitimacy, the first emergent category of themes was the properties of SMS in general. Mentioned by 21% of participants, the most common issue was the speed with which one could respond (kappa=.81), in terms of the turnaround between the researcher asking for a response, and receiving one (including the delay between sending and receipt of questions, and time taken to complete a response). Fifteen percent (kappa=.81) felt the informal nature of SMS communication called into question its appropriateness for research communication. Only 3% (kappa=1) felt that legitimacy was diminished because an SMS from a researcher could be confused with SMS spam. SMS being linked to a contact number and thus not anonymous (mentioned by 8% of participants, kappa=.9) diminished perceived legitimacy.

The next category was concerns participants had on behalf of the researcher. Twenty eight percent (kappa=.88) felt that, as participants could reply to SMS wherever they may be, the researcher had a lack of control over the response environment. The resultant potential for distraction and lack of focus on responding was seen as a threat to the legitimacy of SMS as a response medium. Some (20%, kappa=.68) perceived limited reach of SMS into some demographics, such as the elderly, as diminishing its legitimacy as a tool for research. Similarly, 41% (kappa=.68) mentioned the accessibility of SMS, though only 13% (kappa=.86) felt that the ubiquity of SMS ownership was a strength in terms of legitimacy as a research mode.

The next category related to the necessary brevity of SMS communication. Ten percent of participants (kappa=.7) felt that the legitimacy of SMS was threatened as the response would be too brief in general, 25% (kappa=.87) that it would be too brief to provide a robust answer, and 21% (kappa=.57) felt that the brevity would prevent participants from thinking their answer through. Additionally, 16% (kappa=.57) felt the brevity would beget colloquial responses.

The final category related to issues that would disrupt the participation experience. Participants noted difficulties due to having to scroll to re-read questions due to the small screen size (13%, kappa= .76), difficulty typing responses (40%, kappa=.19) or slowness in typing (13%, kappa= .47), and generally organising their thoughts (23%, kappa= .79).

The working definition of legitimacy established in study 1 captures concerns about conflating research SMS with spam, and brevity of communication, but not distraction or difficulty formulating an adequate response. It was expanded accordingly:

A communication method is legitimate if: (1) You are confident that communications come from a trusted source (2) it is appropriate for the topic being discussed (3) you feel you could use it to provide a comprehensive and accurate answer.

The importance of evaluating SMS in comparison with other research tools is supported by the relatively high number of responses that spontaneously mentioned other research modes.

Study 3

This final study applied the definition of legitimacy developed in studies 1 and 2, and examined participant perceptions of legitimacy of SMS relative to other modes used in self-report data collection.

Participants

One hundred and forty four participants aged 14-72 (M=29), 74% female, participated in return for a choice of course credit, or a small monetary incentive.

Materials and procedure

Participants completed an online survey consisting of questions about mobile ownership and usage, and opinions regarding the legitimacy of using SMS for psychological research. Having been provided with the definition established in study 2, they were asked for their rating (e.g. *On a scale of poor/neutral/good*) and relative ranking (e.g. *Compared to digital device surveys, voice call surveys, in-person interviews, email surveys, online surveys, or post surveys, how would you rank SMS surveys?*) of the legitimacy of SMS a tool for psychological research. They were also asked how much the legitimacy of a research mode mattered to them in terms of their decision to participate in research, on a scale of 0 (does not matter) to 7 (matters very much).

Results and discussion

Mobile ownership was ubiquitous (only 2% did not own a mobile), and 86% owned a smartphone. Most (99%) participants used SMS on a daily basis, averaging 17 per day (ranging from 1-200). The usefulness of clarifying participant perceptions of legitimacy was supported as, on a scale of 0 (does not matter) to 7 (matters very much), a mean rating of 6 indicated that the legitimacy of a mode did matter to participants.

For everyday use of SMS, 45% of participants rated their perception of the legitimacy of SMS as 'positive', 44% as 'neutral', and 11% as poor. For SMS specifically as a self-report research tool, 30% rated it as 'good', 50% as 'neutral', and 20% as 'poor'. The larger number of 'neutral' ratings of the legitimacy for research may reflect a lack of experience with using SMS in the capacity of a participant (hence, a cautious judgement is made). Spearman's rank correlation coefficient for these two ratings indicated that the perceived legitimacy of SMS in everyday life was moderately significantly associated with ratings of the legitimacy of using SMS specifically as a tool for psychological research (ρ=.41, $p<0.01$). Specifically, people who see SMS as a legitimate communication tool in everyday life are also more likely to see it as a legitimate communication tool for research participation.

Despite these positive and neutral ratings, SMS legitimacy ranked relatively poorly compared to other modes. 27% of participants ranked SMS as the least legitimate mode. The research mode ranked as most legitimate was in-person interview, which was ranked first by 76% of participants. Following this was voice calls, online surveys, and finally post and email surveys – all ranked, on average, as more legitimate than SMS.

General Discussion

Across three studies, a definition of legitimacy of SMS as a tool for psychological research was developed and used to explore participant perceptions of SMS in a self-report research context. As in the wider literature, almost all participants owned mobile telephones, and used SMS (ACMA, 2011; Kuntsche and Robert, 2009; Mackay and Weidlich, 2009). This demonstrates that the majority of the population sampled had both the technology and the knowledge to be participants in SMS research. Information regarding any given sample's attitude toward SMS in general could be helpful in inferring how they would feel about it in a research context (Venkatesh, Thong, and Xu, 2012). The current study did indeed find that perceived legitimacy of SMS in daily life was significantly associated with its perceived legitimacy as a tool for psychological research. This suggests that population's attitude toward SMS legitimacy in general is a good point for a researcher to begin establishing whether SMS may be a suitable mode for data collection.

Though developed purely from participant responses, the three elements of the developed definition of legitimacy are consistent with concepts found in the literature. Firstly, *You are confident that communications come from a trusted source* relates to the perceived trustworthiness of the researcher. This is in line with the literature, such that trustworthiness can be considered an attribute of the researcher, and researcher attributes can impact on participant engagement with research (Groves et al., 1992). The second criterion, *it is appropriate for the topic being discussed,* has not been discussed in a generic sense in the literature, however there is an implicit recognition of the importance of topic appropriateness; several studies have examined the appropriateness of SMS for specific topics, such as sexual health (Lim et al., 2010), coping with violence (Howard, Friend, Parker, and Streker, 2010), or depression (La Rue, Li, Karimi, and Mitchell, 2012). Indeed, SMS has been used to collect self-report data on sensitive topics, including sexual health (Curran et al., 2013), and ongoing schizophrenic symptoms (Ainsworth et al., 2013). The third criterion was *you feel you could use it to provide a comprehensive and accurate answer.* When considering the response content, a researcher should be aware that participants may feel some questions are too broad, or require too much detail to answer. When considering a potential target sample, this criterion is essentially Schleifer (1986)'s perceived capacity to participate, in that a researcher should consider their participant's likely self-efficacy and skill with SMS. If a sample is likely to have difficulty using SMS, as may be the case in an elderly sample with vision or coordination deficits, it is unlikely they would feel able to participate.

The qualitative responses revealed that participants did not consider the modalities in isolation, but rather weighed the relative merits of different modes. This is congruent with Dillman, et al. (2009) noting that the modern participation landscape offers participant choices, including which modes they wish to use. This suggests the legitimacy, or indeed other properties of a mode, should not be considered in isolation, but instead in the context of other modes that may be available to participants. In a comparative context, in-person interviews and postal surveys in particular were seen as more legitimate. This is despite the fact that the legitimacy of both postal survey and SMS is equally diminished by the potential for unsolicited spam (Nancarrow et al., 2004; Schleifer, 1986). The key factor may be the pedigree of each mode as a psychological research mode, with more established modes (such as paper survey or interview) being perceived as more legitimate by virtue of their history of use as psychological research modes. This is discussed by Dillman et al. (2009), who note initial participant hesitance when researchers began to conduct telephone (rather than postal or in-person) surveys. One way of easing this transition was to initially contact or recruit participants using a mode they were comfortable with.

One limitation of the current research is that it did not explicitly distinguish between initial contact, and ongoing responses in participation – rather it was discussed in broad terms of communication between researcher and participant. Because of the preponderance of unsolicited SMS spam, it is possible that perceptions of the legitimacy of SMS as a method of recruitment could be quite different from those of SMS as a response medium following initial contact and recruitment by way of a different mode. Another limitation is the sampling frame. The qualitative development of the concept of legitimacy of SMS as a tool for research in the current paper is strong in terms of a wide age range of participants, and mix of both undergraduate and general population participants. However, all data collection was carried out in Australia. The mobile communication landscape, participation behaviour, and perceptions of SMS in general differ by country (Harzing, 1997; Zhang and Prybutok, 2005), limiting generalizability.

This paper used qualitative methods to develop a definition of legitimacy, as applied to self-report data collection via SMS.

> *A communication method is legitimate if: (1) You are confident that communications come from a trusted source (2) it is appropriate for the topic being discussed (3) you feel you could use it to provide a comprehensive and accurate answer.*

This definition has a number of practical implications for SMS as a tool for self-report research. The researcher should be aware that their SMS-based research may be mistaken for spam or advertising, and should take steps to emphasise the legitimate source and purpose of the SMS to participants. A researcher seeking to promote the legitimacy of their SMS-based research could take several steps to emphasise that their SMS questions come from a trusted source. Suggestions from other areas where SMS is repurposed for formal uses, such as banking, may be applied. For example, the process of introducing SMS banking can be smoothed by formal endorsement of SMS (i.e. the bank reassuring customers of the security of SMS banking), and clarification of how using SMS for this new purpose can be beneficial (i.e. the bank highlighting the convenience of using SMS for banking) (Amin and Ramayah, 2010). To further avoid research SMS being interpreted as spam, the researcher could also use a different mode for initial contact, and specify when the research SMS are to be expected, and which phone number they would originate from.

The current findings also suggest that the researcher should consider participant perceptions of the appropriateness of SMS for discussing the particular research topic. This is not to say SMS should be avoided when the topic is sensitive, but that sensitivity should be evaluated. The third component of legitimacy identified in this study was the ability of the response format to meet the response requirements. This suggests researchers need to carefully consider the nature of the responses they require of participants, and the limitations of the response format they are using. Issues such as amount of detail, subtlety and overall length of useful responses should be weighed during study design. The researcher should also consider participant perceptions of capacity to respond adequately via SMS, and perhaps specifically reassure the participants of the appropriateness of responses using this format if this is question.

The findings of the quantitative studies also provide key pointers for researchers considering whether to use SMS as a research tool. The importance of examining legitimacy was confirmed, as Study 3 established that participants do feel that the legitimacy of a mode is important. In Studies 2 and 3, participants did not feel SMS as a research mode had particularly poor legitimacy, with most holding neutral perceptions. However, SMS ranked poorly against other self-report research methods. In short, whilst SMS was not seen as a particularly bad choice in terms of legitimacy, other modes were seen as preferable. This suggests that poor perceptions of legitimacy are not necessarily a barrier to participation in self-report research via SMS. But, faced with an option of response modes (perhaps from other research competing for the same sample's attention), legitimacy might be a factor that pulls participant choice away from research that uses SMS to collect data. One key finding in the current paper is that perceptions of SMS legitimacy are only poor in the comparative context of other modes. Asking participants why they feel a particular mode is more or less legitimate than SMS for data collection may provide strategies targeting where legitimacy seems to impact most on participant perceptions: the comparative, rather than absolute, perception of SMS legitimacy. A researcher considering SMS should therefore be aware of other modes being used with a target population. If participants have limited time or capacity to participate, and are presented with the option to participate in similar research using different modes, a researcher using SMS would do well to emphasise the legitimacy of their study, perhaps using some of the previously suggested strategies.

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Perceptions of privacy and convenience of SMS as a tool for self-report data collection

Walsh, E.I, Busby Grant, J. & Brinker, J.

Short Messaging Service (SMS) is gaining traction as a tool for data collection in psychological research, but relatively little is known about participant perceptions of this methodology. Across three studies (total N=767), this paper provides insight into participant perceptions of convenience and privacy of SMS, with a focus on its potential as a tool for data collection in comparison with other possible research modes. Responses from members of the general population, undergraduate students, and individuals with and without experience of participating in research via SMS were compared. Overall, participants felt neutral, or positive, regarding the application of SMS as a tool for research. They had positive perceptions of SMS in terms of convenience, but were generally neutral in terms of the privacy of the mode. They were generally willing to participate in a hypothetical SMS study, but ranked SMS below email in terms of preferred research mode. This suggests that researchers should consider using SMS in appropriate study contexts.

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The decision to participate in research can be influenced by factors outside a researcher's control, such as participants feeling that they have the requisite skills to participate (Schleifer, 1986) or possessing a desire to help (Groves, Cialdini, & Couper, 1992). Many factors are within the researcher's control, such as whether an incentive is offered (Bentley, 2004; Wendler, Krohmal, Emanual, & Grady, 2008). One often overlooked factor within the researcher's control is the tool chosen to communicate with participants.

The impact of using a particular data collection tool on recruitment is generally approached in terms of seeking to maximise response rates. Participants preferring a particular mode of responding, such as online or paper questionnaire, are commonly compared in terms of demographic characteristics (e.g. Diment & Garrett-Jones, 2007), with the pragmatic aim of guiding future research as to which mode is most appropriate for a given sample. Whilst useful, this viewpoint is uninformative in explaining why a particular mode is suitable or unsuitable for a particular demographic, and thus what strategies may be employed to improve participant engagement with that mode. Technological advances offering alternatives to traditional postal or telephone interview surveys have significantly broadened the number of tools that might be used to collect data (Dillman, Smyth, & Christian, 2009). Consequently, the appropriate tool for a given population is increasingly related to participant choice, rather than physical access to the requisite response infrastructure (Dillman, et al., 2009).

Only recently gaining traction in psychological research, Short Message Service (SMS) is one such choice. The ubiquity of mobile telephones (Anhoj & Moldrup, 2009), and everyday SMS usage in the general public (ACMA, 2011; Kuntsche & Robert, 2009; Mackay & Weidlich, 2009) make it an attractive bidirectional communication method with participants as they go about their daily lives (Haller, Sanci, Sawyer, Coffey, & Patton, 2006). Research on the properties of SMS as a self-report research mode have so far focussed on specific research topics (e.g. Lim, Sacks-Davis, Aitken, Hocking, & Hellard, 2010) or for use with specific demographics (e.g. Akamatsu, Mayer, & Farrelly, 2006). There is a need to investigate its broader applicability to self-report research in general (Cocco & Tuzzi, 2012; Tomlinson et al., 2009). One major element of a mode's usefulness is how participants perceive it (Dillman et al., 2009). The current paper will be the first to examine participant perceptions of the privacy and convenience of SMS as a tool for data collection in psychological research.

Administration of a questionnaire in a way the participant feels is convenient can considerably reduce the perceived respondent burden (Sharp & Frankel, 1983). SMS in general is a perceived as a convenient mode of communication (Davie, Panting, & Charlton, 2004; Devitt & Roker, 2009; Leung, 2007; Palen, Salzman, & Youngs, 2000). Research that has used SMS as a data collection tool typically does not specifically ask participants to reflect on the convenience of their experience (e.g. Donaldson, Fallows, & Morris, 2014; Gram, Holtermann, Bültmann, Sjøgaard, & Søgaard, 2012; Hebden et al., 2013; Shapiro et al., 2010). When it is commented upon, it is often inferred from response behaviour such as short response times (e.g. Kuntsche & Labhart, 2012). Those studies that do include reflection on the participation experience find positive perceptions of convenience of using mobile phones in general (Kinyua et al., 2013), and specifically SMS (Akamatsu et al., 2006; Lim et al., 2010; Matthews, Doherty, Sharry, & Fitzpatrick, 2008), as a tool for communicating with the researcher. These positive perceptions related to the non-intrusiveness of SMS (Ostojic et al., 2005), and its brevity and immediacy

(Sharifi et al., 2013). This may be related to desirable respondent behaviours, as some researchers, such as Naughton, Jamison, and Sutton (2013) argue that the perception of convenience leads to participants paying more attention to SMS sent by the researcher.

In many instances, such as when research concerns sensitive topics, it is important that participants feel their responses to a researcher will be private. SMS is desirable for research, because it is perceived as a private communication medium by its users (Tebbakha, 2013), and is perceived as more private than voice calls made on the mobile phone (Häkkilä & Chatfield, 2005). This perceived privacy of SMS has been related to intention for its use in other areas where personal information is shared, for example higher perceptions of privacy of SMS banking are associated with a greater intention to use SMS for banking (Amin & Ramayah, 2010). Concerns about privacy can be a barrier to agreeing to receive SMS in general (Bamba & Barnes, 2007), and to participation in research that uses SMS as a communication medium (Déglise, Suggs, & Odermatt, 2012). There is evidence that many participants do not consider the privacy aspects of SMS as a barrier to participation (Kunutsor et al., 2010), although a qualitative study investigating the acceptability of an SMS intervention for high-risk adolescent females did uncover that some participants were cautious about using SMS due to concerns of low privacy (Ranney et al., 2014).

Amongst those who have participated in research using SMS, reflections on the privacy of their experience tend to be positive, indeed, many cite the privacy of the medium as one of its major benefits (Akamatsu et al., 2006; Broaddus & Dickson-Gomez, 2013). As mobile telephones tend to be password protected and kept with the individual, SMS has an advantage over paper diaries that are easily misplaced, or read by third parties (Matthews et al., 2008). Participants generally feel that maintaining SMS privacy is the responsibility of the researcher (Siedner, Haberer, Bwana, Ware, & Bangsberg, 2012). The researcher may use strategies to enhance apparent and actual data privacy, such as omitting personally identifying details from the SMS (Joung et al., 2012), ensuring the format of the SMS is inscrutable (such as a string of numbers) to a third party (Donaldson et al., 2014), encrypting the content of the SMS before it is sent (Matthews et al., 2008), or using code words so the SMS is impenetrable to those not directly involved in the study (e.g. Curioso et al., 2009).

Participant perceptions of the convenience and privacy of SMS as a tool for research may provide useful insights into the utility of SMS for psychology data collection. Across three studies, this paper aims to provide a preliminary insight into participant perceptions of the convenience and privacy of SMS, with a focus on its potential as a tool for data collection. A pragmatic benefit of doing do is to establish whether perceptions of SMS as a tool for research may explain willingness to participate in research where it is used to collect self-report data.

Study 1

This study aimed to establish perceptions of privacy and convenience of SMS in general.

Participants

Four hundred and thirty members of the general public who had not yet participated in research via SMS were recruited through personal mailing lists and international online survey panel services. Aged 19-79 (M=37), 60% were female.

Materials and procedure

Participants completed an online questionnaire, including demographic information, and questions about mobile telephone ownership and usage. They rated the convenience and privacy of SMS as a communication tool in general on a scale of 'good', 'neutral', and 'poor'.

Results and discussion

Mobile ownership was ubiquitous, with smart phones being the most common type of mobile handset owned (74%). Most participants used SMS on a daily basis, ranging from 0-250 sent per day (an average of 7 per day). Over half of participants (56%) had positive perceptions of the convenience of SMS in everyday use, 34% felt neutral, and 10% felt the convenience was poor. Similarly, half of participants (50%) had positive perceptions of the privacy of SMS in everyday use, 37% felt neutral, and 13% felt it was poor.

Logistic regression revealed a significant association between number of SMS sent per day and perceptions of SMS convenience (b=0.029, SE=0.01, p=0.047), with those using SMS more on a daily basis rating it as a more convenient communication tool in general. Self-reported daily SMS usage was not significantly associated with perception of privacy.

Study 2

This study aimed to establish perceptions of privacy and convenience of SMS as a tool specifically for psychological research, in samples with different experiences of SMS research (i.e. a mixture of people who have and have not participated in SMS research).

Participants

Data was collected from three Australian undergraduate samples recruited via poster advertisements, and participating in return for course credit. The three samples did not overlap (i.e. the same individual could not participate in more than one of the three studies). The first sample consisted of 36 students had volunteered to participate in research via SMS, but who had not yet participated. Aged 18-62 (*M*=24), 75% were female. The second sample consisted of 85 students who had participated in research via SMS. Aged 18-46 (*M*=21), 74% were female. The third sample consisted of 72 students exiting a larger repeated measures study where they responded via SMS Aged 17-64, (*M*=22), 71% were female.

Materials and procedure

All samples completed an online questionnaire, including demographic information, and questions about mobile telephone ownership and usage. They then rated the privacy and convenience of SMS as a tool for psychological research on a scale of 'good', 'neutral' and 'poor'.

Results and discussion

Mobile ownership was ubiquitous across all samples, with smart phones being the most common type of mobile handset owned. Most participants used SMS on a daily basis, with considerable ranges in average number of SMS sent per day (Table 1).

All samples held generally positive perceptions of SMS as a tool for data collection (Table 1). Perceptions of privacy were also generally positive, or neutral. Logistic regression revealed no significant associations between the number of SMS sent on an average day, and perceptions of the privacy or convenience of SMS as a tool for psychological research. There were no significant differences in terms of perceptions of privacy or convenience between those with and without experience of using SMS in the course of research participation.

Table 1.

Mobile demographics and perceptions of SMS convenience and privacy

Sample	% Own a mobile		Smart	Av SMS/day	Conv			Priv		
	One	Multiple	Smart		Pos	Neu	Poor	Pos	Neu	Poor
First undergraduate sample (n=36)	100%		86%	6-13 M=16	94%	2%	2%	41%	50%	9%
Second undergraduate sample (n=85)	95%	5%	94%	1-200, M=45	58%	27%	5%	67%	18%	3%
Third undergraduate sample (n=72)	90%	6%	70%	0-200, M=17	80%	15%	5%	76%	19%	5%

Note. Percentages may add to less than 100% due to missingness in the data.

Study 3

This study aimed to establish the relationship between perceptions of privacy and convenience of SMS in general, as a tool specifically for psychological research, in a comparative context of other modes.

Participants

There were 144 participants: 81 members of the general population, and 63 undergraduate students. Twenty three had previously participated in SMS research, as this subsample did not significantly differ from those who had no SMS research experience on any of the variables of interest they were included in subsequent analyses. Some members of the general population participated voluntarily, others for a small monetary incentive, and the undergraduate students earned course credit. Ages ranged from 14 to 72 (M=29), 74% were female.

Materials and procedure

Participants completed an online survey consisting of questions about mobile ownership and usage, and opinions regarding using SMS for psychological research. These questions consisted of both ratings (e.g. *On a scale of poor/neutral/good*) and relative rankings (e.g. *Compared to digital device surveys, voice call surveys, in-person interviews, email surveys, online surveys, or post surveys, how would you rank SMS surveys?*). The survey concluded by asking participants how important the mode used for research, and further how important the privacy and convenience of a research mode is in guiding their decision whether or not to participate in research.

Results and discussion

As in study 1, mobile ownership was ubiquitous (only 2% did not own a mobile), and 86% owned a smartphone. Most (99%) participants used SMS on a daily basis, averaging 17 per day (ranging from 1-200). Participants indicated that the method of communication the researcher wants to use somewhat mattered when considering participating in research (M=5, on a scale of 0=not at all through 7=very much). Overall, participants generally felt neutral about SMS in terms of privacy of using SMS in their everyday lives, and for research, but positive about it in terms of convenience (Figure 1). Logistic regression did not reveal any significant association between daily SMS usage, and perception of the privacy or convenience of SMS as a tool for psychological research.

Spearman's rank correlation coefficients revealed that ratings of the privacy (ρ=.47), and convenience (ρ=.53) of SMS in general were significantly associated with perceptions of using SMS specifically as a tool for psychological research ($p<0.01$). Logistic regression revealed no significant differences in ratings of the privacy, security, convenience and legitimacy of SMS as a tool for psychological research between the undergraduate and general population, (as can be seen in Figure 1).

The significant association between perceptions of SMS in general and for research, and the lack of differing perceptions of privacy and convenience between those who have and have not participated in research via SMS indicates consistency. This may be helpful, as it suggests that if a given sample feels positively about SMS in their everyday lives, they may feel positively about its use in research both before and after participation.

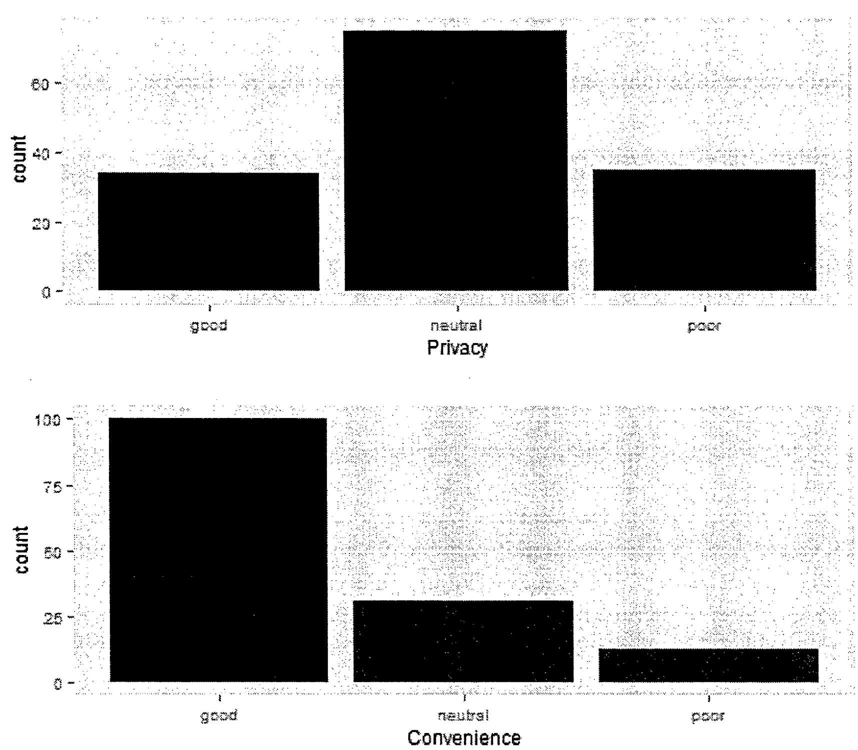

Figure 1. Ratings of SMS privacy and convenience

The relative ranking of SMS against other research modes, and the poor/neutral/good ratings were significantly moderately correlated, such that higher rankings relative to other modes were associated with more 'good' ratings (table 2). The fact this correlation was not stronger demonstrates that placing SMS in the context of other modes provides additional information to simply rating it in isolation.

Table 2.

Summary of ratings and rankings of SMS privacy, security, legitimacy and convenience

	Absolute and relative rankings		
	Median rating	Median rank	Rating/ranking correlation
Privacy	Neutral	5th	-.36*
Convenience	Good	3rd	-.44*

Note. * indicates significance at p≤ .05.

Relative to the other seven modes of data collection presented to participants ranked poorly in terms of privacy, but well in terms of convenience (Table 2, Table 3). Online survey (ranked as most preferred by 54%) was the preferred mode of communicating with researchers, and post the least (ranked as most preferred by 3%), with SMS generally ranked in the middle (ranked as most preferred by 8%). Thirty five percent of the 121 participants who had not already participated in research via SMS said they would hypothetically be willing to do so, 53% said they might, and 12% said they would not.

Table 3.

Median rank of research modes

	SMS	Email	Post	Online	Voice Call	Interview (in person)	Digital device
Privacy	5	4	5	3	5	1	3
Convenience	3	3	6	2	4	6	5
Preference	4	5	6	1	5	5	4

Note. Lower numbers indicate higher rank (i.e. 1=highest, 7=lowest).

Ratings on a scale of 0 (does not matter) to 7 (matters very much) indicated that it did matter to participants whether a mode was private (M=5.7) or convenient (6.2). However, regression revealed no significant relationship between willingness to hypothetically participate and ratings of the privacy or convenience of SMS as a tool for psychological research. Addition of demographic variables (age, gender, phone type, self-reported daily SMS usage, or being an undergraduate) as predictors or potential suppressors did not uncover a significant relationship.

General Discussion

Across three studies, participant perceptions of the convenience and privacy of SMS were explored, with a focus on its potential as a tool for data collection. As may be expected given mobile ownership and SMS usage rates reported in the literature, mobile ownership and SMS usage was ubiquitous (ACMA, 2011; Kuntsche & Robert, 2009; Mackay & Weidlich, 2009). This is promising, as it shows that both undergraduate and general population sampled had the capacity (i.e. the infrastructure and technical knowledge) to participate in SMS research. Perceptions of SMS usage in everyday life were significantly associated with perceptions of its use specifically for research. In line with the assertion that previous experiences with a technology can inform attitudes toward its further use (Venkatesh, Thong, & Xu, 2012), information about how a particular sample feels about SMS in general may be helpful in guiding researchers may help to inform how participants feel about SMS for research purposes.

SMS was perceived in the current studies as in the literature as a convenient method of everyday communication (Davie et al., 2004; Devitt & Roker, 2009; Leung, 2007; Palen et al., 2000). Similarly, it was generally perceived as a convenient method for communicating with researchers (Akamatsu et al., 2006; Lim et al., 2010; Matthews et al., 2008), particularly in comparison with postal surveys. Interestingly, heavier daily usage of SMS was significantly associated more positive perceptions of the convenience of SMS for general use, but not as a tool specifically for research. Every day SMS usage was not related to perceptions of privacy, and participants generally felt neutral regarding the privacy of using SMS either in general or for research. This indicates that that researchers interested in perceptions of privacy and security of SMS for data collection should directly ask potential participants rather than look at everyday SMS usage as a proxy measure.

Results supported the proposition that participants weighed the relative merits of different tools for responding to researchers when formulating their opinions about the convenience and privacy of SMS as a tool for psychological research, suggesting that data collection methods are best conceptualised in terms of choice of a variety of options (Dillman, et al., 2009). It may be therefore more meaningful for future research to consider participant perceptions of SMS *relative* to other modes that may be used, rather than in absolute terms. This highlights a limitation of the current investigation, in that Study 3 focussed specifically on willingness to participate in research via SMS. Doing so did not account for overall willingness to participate in research *per se.* Though by virtue of being respondents in the current study it can be taken that all participants are at least somewhat willing to participate in psychological research, there is no way to disentangle overall participatory intention from intention specific to SMS. Future research should include both these variables. The importance of such future investigation is emphasised by self-report indicating that the data collection tool used, and perceptions of its privacy and convenience, does matter to participants when considering participation in research.

Across three studies, this paper investigated participant perceptions of the convenience and privacy of SMS, with a focus on its potential as a tool for data collection. Perceptions of SMS for everyday usage were significantly associated with perceptions of SMS as a tool for data collection. Participants generally felt neutral or positive about the privacy and convenience of using SMS to respond to researchers. Yet, there was no significant association between participant perceptions of SMS as a research tool, and hypothetical willingness to participate in research via SMS. Willingness to participate was not associated with demographic factors, including average daily SMS usage, or being an undergraduate or a member of the general population. The challenge for future research is to establish the mechanisms underlying this disconnect between perceptions and willingness to participate in research via SMS. For, now, as in fields such as disease prevention (Déglise et al., 2012), it concluded that poor perceptions of convenience and privacy are not a barrier to participation in research that uses SMS as a tool to collect self-report data.

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A tool for all the ages? SMS as a method for data collection with across a wide age range, an expectancy approach

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Due to its ubiquity and convenience, Short Message Service (SMS) could be used as a tool for support self-report data collection in psychological research. To help researchers ascertain if SMS is suitable for particular samples, this paper explores the association between participant attitudes toward SMS for everyday purposes, and attitudes toward SMS as a tool for psychological research. These attitudes are discussed in the context of age because of the widely documented differences in technology uptake, and SMS usage, as a function of age, these attitudes were discussed in the context of age. Study 1 is a series of qualitative semi-structured interviews completed by 18 participants (aged 18-74). Study 2 is a quantitative online survey completed by fifty children (aged 5-17) and 269 adults (aged 18-79). Attitudes relating to general SMS usage were meaningful predictors of attitudes toward using SMS for the purposes of research. Increasing age was associated with lower self-efficacy, greater sensitivity to an external locus of control, and thus a less positive attitude toward using SMS in general, and specifically using SMS for psychological research. However, attitudes were not significantly associated with actual participation behaviour.

Mobile ownership is ubiquitous in Australia (ACMA, 2013), and worldwide (Kuntsche & Robert, 2009). Constant use of SMS in many people's daily lives heralds a unique opportunity for communication between psychology researchers and their participants, potentially facilitating self-report data collection with minimal disruption to the participant's daily activities (Haller, Sanci, Sawyer, Coffey, & Patton, 2006). As a relatively new phenomenon, there is little exploration of how SMS can be best used for self-report research. Because technological engagement is associated with age (Venkatesh, Thong, & Xu, 2012), one component of investigating the applicability of self-report research to age is establishing whether SMS is notably appropriate, or inappropriate, for use with specific age groups. Attitudes toward SMS in daily life, and every day SMS usage, could be used as an indicator for attitudes toward using SMS in a research context, and SMS response behaviour. If this is a valid approach, researchers considering the feasibility of collecting self-report data via SMS with a particular age group could seek information about that age group from the large literature surrounding SMS usage in daily life, either as a preliminary step or in place of time consuming and costly prospective pilot studies.

People of different ages use SMS for different purposes, in differing frequencies, and differing situations (Devitt & Roker, 2009; Ling, 2002, 2010). Many children own mobile telephones (Downie & Glazebrook, 2007), and mobile phone use increases with age (Devitt & Roker, 2009). Though many children do have experience with SMS (Davie, Panting, & Charlton, 2004), younger children prefer to use voice calls (Plester, Lerkkanen, Linjama, Rasku-Puttonen, & Littleton, 2011). Estimates of mobile ownership amongst teenagers is consistently upwards of 80% (Inyang et al., 2010; Ling & Haddon, 2008; Pain et al., 2005). Older teenagers are more likely to own a mobile phone than younger ones (Pain et al., 2005). Teenagers use their mobile telephones heavily (Charlton, Panting, & Hannan, 2002; Pain et al., 2005) (Charlton et al., 2002; Ling, 2002) with some samples reporting sending 100 SMS on a daily basis (Michalopoulos, Papadopoulos, & Mavridis, 2012). Mobile telephone ownership and SMS usage in adults is also ubiquitous, if less intensive. Almost a quarter of the adult Australian population reports that SMS is their most used method of communication (ACMA, 2013). The elderly are the least active users of mobile telephones, with mobile ownership and SMS usage dropping sharply with increasing age (Ling, 2008b; Smith, 2011), but many elderly do own mobile phones, often for reasons of personal safety and telecare (Abascal & Civit, 2001; Eardley et al., 2009; Barlow, Singh, & Bayer, 2007). Though they prefer voice calls, a reasonable portion (up to 23%) of the elderly do use SMS (Lobet-maris & Henin, 2002; Mallenius, Rossi, & Tuunainen, 2007).

Turning to SMS as a tool for self-report data collection, younger individuals tend to prefer technological methods of participation such as SMS (Matthews, Doherty, Sharry, & Fitzpatrick, 2008; Shapiro et al., 2008), whilst older participants prefer traditional alternatives such as voice calls (Theiler et al., 2007). The most common age groups sampled in SMS-based research are teenagers (e.g. Rami, Popow, Horn, Waldhoer, & Schober, 2006; Reid et al., 2009; Rhee, Allen, Mammen, & Swift, 2014) and young adults (e.g. Curran et al., 2013; Iribarren et al., 2013; Song, Foo, & Uy, 2008). SMS has been successfully used to collect self-report data from children (e.g. Chen, Chin, Greenberg, Johnstone, and McGuinness, 2012 and De Niet et al., 2012), but there has been no research using SMS as a data collection tool with the elderly. The oldest mean age in a study using SMS for data collection is 58.3 (in Donaldson, Fallows, & Morris, 2014). This may reflect that researchers implicitly consider the comparatively low levels of SMS usage in older adults as an indicator that they are an inappropriate group for SMS-based data collection.

The expectancy model of mobile telephone usage is based on Davis, Bagozzi and Warshaw (1989)'s Technology Acceptance Model (TAM) and its later expansion, Venkatesh, Morris, Davis and Davis (2003)'s Unified Theory of Acceptance and Use of Technology (UTAUT). These models share roots in the theory of reasoned action. The central tenet of this theory is the separation of behavioural intention from actual behaviour, that is, a genuine intention to undertake an action does not invariably result in that action being taken (Sheppard, Hartwick, Warshaw, & Hartwick, 1988). For example, Mallenius et al. (2007) found low adoption of mobile telephones in an elderly sample, despite their self-reported positive attitudes toward mobile telephones. There is, however, evidence that intention and action may be related for collection methods, as Dillman et al., (2009) discuss how general attitudes toward a particular tool for data collection are associated with recruitment and response behaviour.

This paper investigates the possibility that attitudes and behaviours surrounding SMS usage in everyday life can be used as an indicator for attitudes and behaviours relating to using SMS as a tool for self-report data collection. Because technology attitudes and usage differ by age (Venkatesh et al., 2012), this will be examined across a wide range of ages. Doing so will provide a reference for future researchers deciding on the appropriateness of SMS for data collection with their specific samples. Framed by Mahatanankoon and O'Sullivan (2008)'s expectancy model, study 1 approaches the topic from a qualitative standpoint, while study 2 investigates the same questions in a quantitative manner.

Study 1

This study used qualitative methods to investigate whether behaviour and attitudes toward SMS in everyday life were associated with attitude and behaviours toward SMS in a research context. This was framed in terms of Mahatanankoon and O'Sullivan (2008)'s expectancy model, with questions focussing on locus of control, self-efficacy, and anxiety, and their association with attitude.

Here, locus of control refers to the perceived capability to control the SMS behaviour and outcomes. Those with an internal locus of control feel they are able to exert control over their SMS usage and its outcomes, whilst those with an external locus of control feel that their SMS usage and its outcomes are more due to environmental influences. For both ends of the age spectrum, one might expect a relatively external locus of control for SMS engagement. Child mobile phone usage is monitored and shaped by parents (Vincent, 2004), who further serve as the gatekeeper for consent when participating in research (Inyang et al., 2010). Elderly mobile phone usage is often dependent on their adult children purchasing the mobile phone, and teaching them how to use it (Mallenius et al., 2007). In contrast, teenagers tend to be responsible for their own mobile phone purchase (Davie et al., 2004; Hoflich & Rossler, 2002), and exert almost complete control over their engagement with their mobile telephones, often as a method of gaining independence from their parents (Ling, 2002; Riviere, 2002; Weisskirch, 2011).

Self-efficacy as defined here is similar to locus of control, but rather than focussing on perceived control, it relates to perceived ability or skill. Here, those with high self-efficacy feel they are capable of using SMS, whilst those with low self-efficacy doubt their capacity to successfully use the technology. As the elderly in particular tend to have lower levels of self-efficacy when asked to use an unfamiliar technology (Lam & Lee, 2006), and are less likely to use SMS (Ling, 2008a), it is quite likely that age will be associated with self-efficacy for using SMS as a tool in psychological research, with older participants reporting lower self-efficacy. Self-efficacy is likely to be negatively associated with anxiety, as particularly in the elderly, a high sense of self-efficacy can protect individuals from experiencing anxiety when using technology (Lam & Lee, 2006).

Anxiety is defined here as a tendency to be apprehensive or fearful about using SMS, stemming from issues such as fear of making mistakes or not understanding how to use the technology properly. Drawing on the computer anxiety literature, anxiety decreases with experience (Chang, 2005), but there is conflicting evidence relating to the relationship between anxiety and age. Some studies finding a clear increase in computer anxiety with age (Laguna & Babcock, 1997), others a decrease (Dyck & Al-Awar Smither, 1994), and a meta-analysis finding the presence or absence of an effect was dependent on the age range sampled (Chua, Chen, & Wong, 1999).

Method

Participants. Eighteen members of the general Australian public were recruited via posters and online advertisements targeting specific age ranges. Seventy eight percent of participants were female. Ages ranged between 18 and 74 years, with at least two participants from each age band of 18-22, 23-24, 25-30, 31-49, 50-54, and 59+, such that interviewees spanned the full age range of adulthood.

Materials and procedure. Posters and online advertisements explained the topic of discussion would be everyday SMS usage, and the possibility of using SMS as a tool for researchers. Participants were provided the option of being interviewed via telephone, or in person during an appointment on the university campus. Thirty to sixty minute semi-structured interviews followed the framework of the expectancy model. Interviews were recorded and transcribed. Recurrent themes were extracted from the a-priori categories of locus of control, self-efficacy, anxiety, and attitude toward SMS. The frequency of these themes across participants, and whether frequency and content differed across the age range was coded independently by two researchers. Their coding was in agreement more than 90% of the time. In the interests of space, percentages reported are from one researcher.

Results

All participants owned a mobile telephone. Self-reported daily SMS usage averaged 7 per day (ranging 0-50 across participants). Most (72%) had not previously participated in research that used SMS.

Locus of control. Feelings about whether using SMS in general was within the participant's control were mixed, with half of participants stating that it was somewhat their choice, and somewhat due to the expectations of others. Common themes were social expectation (mentioned by 33%) and the ubiquity of SMS (mentioned by 22%). These themes were present across ages.

> "It's not that others expect me to, but it's now become, this is the way to communicate more often. [...] Especially now that trying to find a public phone box is almost impossible." (*ED,* age 63)

When presented with the hypothetical scenario *"Imagine a researcher said you had to use SMS to participate in their study, and did not give you any other option. Would this make you more or less likely to agree to participate"*, 27% of participants felt the lack of choice would make them less likely to participate, whilst 16% felt it would not have impacted on their decision. A further 27% said it depended on properties of the survey. These concerns were not age specific.

> "It depends on the content of the study. I might be suspicious if I can't see a good reason to use SMS over other methodologies." (*EC,* age 24)

> "If it's a yes/no type survey, or choose A, B, C or D, obviously that's not going to be too laborious. But, if it involves doing multiple answers on a little screen, that would drive me mental and I wouldn't do it." (*LS*, age 54)

Self-efficacy. Almost all (95%) of participants reported being confident in sending and receiving SMS in general. Self-efficacy in relation to using SMS as a research participant was generally discussed in terms of whether participants felt they would need help, could seek help, and whether they felt they could participate in a reasonable time frame.

All participants felt they could use SMS for research even if there was no one available to provide help. When asked if they would be comfortable seeking help if needed, 77% said they would be. Additional comments indicated that, though the question was specifically about SMS, participants were thinking about seeking help for completing research more broadly.

> "I don't think I'd want to. If I was doing a survey by myself, I'm the one being surveyed, asking someone to help would mean it's not me, it's them." (*ED*, age 63)

Only the oldest participant felt that they could only participate if provided a lot of time to compose their responses.

> "Because I find it very difficult to do the keys. It takes me ages to compose a text message, you know, to tap it out." (*HH,* age 74)

A third of participants felt the inherent brevity of SMS meant that they could expect short questions, and thus be able to answer quickly.

> "I would imagine, I could participate, after all, text messaging is not going to require an essay to reply, as the nature of text messaging is brevity." (*AMM,* age 67)

A third of participants also mentioned that they do not always have their mobile phone with them, so they may struggle with a delay in receiving (and subsequently replying) to the SMS. This sentiment was not limited to older participants.

Anxiety. No participants felt anxious about the process of sending an SMS, and only one (age 39) felt anxious about receiving them. None of the participants found the idea of responding to a researcher via SMS intimidating.

> "No. I think it's less intimidating, because you don't have to give your answer to the researcher. I think you feel less obliged to reply in that sort of social desirability way, because you're not actually with someone." (*CK*, age 19)

Over two thirds (69%) of participants would not be anxious that they may lose information when responding via SMS. Across ages, those who expanded on their reasoning tended to discuss anxiety over information loss in terms of other modes of participation.

> "I would be more fearful than using an online source." (*CW*, age 18)

> "No more than I could lose it than on an email, or loose a phone call when you're talking to somebody and the phone call is cut - you've got no record of what's been said." (*AMM*, age 67)

Attitude. Older adults reporting fewer SMS sent on an average day than younger adults (i.e. HH, 74, reported sending none, whilst RC, 23, sending 50 or more), however, attitude toward SMS in general did not differ by age. Just over half (55%) of participants felt positively about SMS in their everyday lives, while 39% reported mixed feelings. Benefits of SMS in everyday life mentioned included it being time efficient, and detriments included its brevity leading to lack of context, leading to a preference for voice calls.

> "It hasn't made it [my life] worse. Hasn't made it better. Look, it's a time saving device, for times when you just want to give a quick response and you don't necessarily want to speak to that person. But if it involves a long winded response [...] I'd just as soon pick up the phone and ring and get it out, rather than three or four texts." (*LS*, age 54)

A quarter (44%) of participants felt that participating in research via SMS could be enjoyable, though almost two thirds (64%) did not think that using SMS would make a study more or less interesting to them. A continual theme across all age groups was that their interest in a particular research project is due to its content, rather than the mode with which it is carried out.

> "It's always the content for me that matters the most. Yeah, I really don't think it [using SMS] would affect my evaluations of the research." (*HB*, age 21)

Just over half (52%) of participants felt using SMS for research is a good idea, 23% thought it a bad idea, and the remaining participants had a mixed sentiment. Though there was no clear pattern in opinion regarding personal capacity associated with age, the two participants who spontaneously noted the suitability of SMS for research was dependent on age were older (aged 47 and 74). The shortness of SMS was cited as a problem by 30% of participants.

> "I don't think it is a good idea, because of the back and forwards needs for all the questions. I do think it might be a good way for very brief surveys, sort of a twitter type interactive manner." (*DMLB*, age 63).

Discussion

As in the wider Australian public, mobile telephone ownership and SMS usage was present across all ages (ACMA, 2013; Inyang et al., 2010). Attitudes toward SMS in everyday life, and for research purposes were positive, but not overwhelmingly so. Discussion of the role of SMS in everyday life suggested that the ubiquity of SMS use amongst peers obliged participants to use SMS themselves, but that this did not translate into particularly negative attitudes toward their SMS usage. Attitudes toward SMS were nuanced, and often related to the length of the communication. Across several areas of discussion, it was clear that participants felt positively toward using SMS for brief messages, but felt it was unsuitable for longer communication. This was the case for both everyday SMS usage, and using SMS specifically for research purposes. Aside from reflecting the practical reality of the character limitation inherent in SMS, this suggests that the brevity of SMS is highly salient for potential research participants.

Although older participants reported sending fewer SMS on a daily basis, this study found no a clear association between age and discussion of locus of control, self-efficacy anxiety, and attitudes toward SMS in everyday life, or for research purposes. This may reflect a genuine lack of association between age and attitudes toward SMS, but this would run contrary to expectations from the literature (Devitt & Roker, 2009; Ling, 2002, 2010). One possibility is that social desirability effects associated with in-person interviews may have led to the under-reporting of negative attitudes or difficulties with using SMS to avoid embarrassment. Another is that the explicit mention of SMS during recruitment dissuaded participants who had negative opinions of SMS from participating in the current study, thus biasing sampling of (particularly older) participants and diminishing the expected relationship between age and attitudes.

Either possibility could explain why the two participants who spontaneously mentioned that SMS may not be suitable for conducting research were themselves older. Generally stated reservations about conducting research via SMS with older individuals may be indicative of undisclosed personal reservations about using SMS in a research context. Alternatively, these remarks may be based on these participant's observation of their less technologically savvy peers.

These results indicate that everyday experience with SMS inform participant expectations of SMS in a research context. For example, knowing how long it takes to type an everyday SMS informed expectations of how long it would take to respond to a research SMS, and knowing that everyday SMS tend to be short raised concerns about using SMS if research involved long questions. Common themes emerged when discussing attitudes (and underlying locus of control, self-efficacy, and anxiety) regarding everyday SMS usage, and using SMS specifically in a research context. This tentatively supports the assertion that attitudes and behaviours surrounding SMS usage in everyday life can be used as an indicator for attitudes and behaviours relating to using SMS as a tool for self-report data collection.

Study 2

This study used quantitative methods to investigate whether behaviour and attitudes toward SMS in everyday life were associated with attitude and behaviours toward SMS in a research context. Mahatanankoon and O'Sullivan (2008)'s expectancy based model was modified slightly to allow for the potential impact of age (either as a mediator of the relationships within the model, or a correlate of the elements within the model), and simultaneous modelling of both every day and research-specific attitudes.

Method

Participants. Participants were recruited via online survey panel service Qualtrics. To ensure a wide spread of ages, a minimum of fifty participants from each of the following age bands were recruited: 5-14, 15-29, 29-35, 36-49, and 50 or older. The child sample consisted of fifty participants aged between 5 and 18, 50% of whom were female. The adult sample consisted of 269 members of the general Australian public aged between 18 and 79, 63% of whom were female.

Materials. Both adult and child samples completed online questionnaires based on the original expectancy model instrument developed by Mahatanankoon and O'Sullivan (2008), and additional demographic questions regarding SMS usage. The instrument contained questions about attitudes toward everyday SMS usage, and parallel questions about using SMS in a research context. To mitigate wording effects, there were two versions of the adult instrument, with counterbalanced wording (i.e. "Are you *more* likely to…" vs "Are you *less* likely to…"). Unless otherwise specified, all responses were Likert ratings on a scale of 0 to 7, where 0 signifies complete disagreement, and 7 signifies complete endorsement[2]. In preparation for structural equation modelling, single items and item parcels (consisting of the sum of constituent items) were used as manifest variables rather than specifying single-item and two-item latent factors in the interests of model stability.

Attitude. Attitude toward SMS in everyday life was measured by a single item (*"What is your attitude toward how you use SMS in your everyday life?"*). Attitude toward SMS specifically in a research setting was measured by the sum of three significantly positively correlated items (*"Is using SMS for research is a good or bad idea?", "Could responding with SMS for research be fun?", "Would using*

[2] Variable labels were specific to the question, i.e. a question asking 'do you agree' had 0=not at all agree to 7=very much agree, whereas a question asking 'would you find SMS useful' had 0=not at all useful to 7=very useful

SMS would make participating in research more or less interesting?", all correlations significant at $p<0.001$).

Locus of control. Locus of control for SMS in everyday life was measured by a single binary item, *"Do you feel you are currently using your mobile phone because you want to, or because others expect you to?"(it is mostly because I want to / it is mostly because others want me to).* Sensitivity to locus of control in SMS in a research setting was measured by a single question, *"Imagine a researcher said you had to use SMS to participate in their study, and did not give you any other options (such as paper or online survey). Would you be more or less likely to participate than if you had been given other options and chosen to use SMS?"*

Self-efficacy. Self-efficacy for SMS usage in everyday life was measured by the sum of two significantly positively correlated items (*"Are you confident in your ability to send SMS?", "Are you confident in your ability to receive SMS?"*, ρ=.9, $p<.001$), and was significantly negatively skewed (z = -5.84, $p<0.001$). Self-efficacy relating to using SMS specifically for research was measured by the sum of three significantly positively correlated items (*"Thinking about participating in psychological research using SMS, you are confident that you could participate if there was no one around to tell you what to do as you go", "Thinking about participating in psychological research using SMS, you are confident that if you needed to, you could ask someone for help if you got stuck", "Thinking about participating in psychological research using SMS, you are confident that you could participate even if you did not have a lot of time to complete the questions you had been asked"*, all correlations significant at $p<0.001$).

Anxiety. Anxiety relating to every day SMS usage was measured as the sum of two positively correlated items (*"Does the process of sending an SMS make you nervous?", "Does the process of receiving an SMS make you nervous?"* ρ=.87, p<.001), and was significantly positively skewed (z =3.583, p<0.001). Similarly, anxiety relating to using SMS for research purposes was measured as the sum of two positively correlated items (*"Does it scare you to think that you could lose a lot of information using SMS for participating in research?", "Is the idea of using SMS for participating in research is somewhat intimidating to you?"*, ρ=.51, p<.001).

Follow-up. The questionnaire concluded with an invitation to provide a mobile number to participate in a short follow-up survey to be completed via SMS. This invitation made it clear that there was neither incentive nor penalty for providing the mobile number. This follow-up survey consisted of a 16-item self-report wellbeing instrument, the Acceptance and Action Questionnaire (Hayes, et. al, 1996).

Child version. The instrument length and wording was adapted for the child sample. Wording was pilot tested on a small sample (n=4) and modified according to parent and child feedback. To keep the instrument short, the child sample completed a series of questions only regarding the use of SMS as a tool for psychological research. All variables were measured by a single likert scale item: locus of control (*"Before you talked to researchers using SMS, would you ask other people if it was OK?"*), self-efficacy (*"Do you think you would need help to talk to a researcher using SMS?"*), anxiety (*"Would you worry about mucking up your answer by pressing the wrong key if a researcher asked you a question using SMS?"*), and attitude (*"Do you think psychology researchers should use SMS to talk with their* *participants?"*). Due to the ethical considerations of asking a minor for contact details, children were not invited to participate in the SMS follow-up survey.

Results

Child and adult data were analysed separately. Where variables violated the assumption of normality, non-parametric equivalents (Spearman's ρ, Welch Two Sample t-tests) were used. Item parcelling resulted in unequal ranges for some variables (i.e. a variable with one item ranges 0-7, a variable measured by two items ranges 0-14). While these ranges were retained in analyses, in the interests of consistency descriptive results are re-scaled so that mean responses are expressed on a scale of 0-7 (i.e. mean response for a variable measured by two items).

Children. Just over half of the children (54%) owned a mobile telephone. They were somewhat confident in their capacity to participate in research via SMS (M=5). Children had moderate anxiety about using SMS for psychological research (M=4). Overall, child participants were ambivalent about the idea of using SMS as a tool for psychological research (attitude M=4). Likely due to the combination of small sample size, and unstable item parcels, expectancy models for child data were unstable and did not converge. Age was significantly negatively correlated with self-efficacy (ρ=-.31, p=.02), and anxiety (ρ=-.36, p=.01).

Adults. All adult respondents owned at least one mobile telephone. Most (75%) indicated they were very experienced with using SMS, and reporting sending an average of 7 SMS per day (ranging from 0 to 100 SMS across participants). Age was not significantly correlated with SMS usage. The majority (93%) stated they did not have any experience participating in research that uses SMS as a communication tool. Very few (12%) reported a feeling of an external locus of control for their everyday SMS usage.

Generally, participants reported that a researcher imposing the SMS mode (rather than them using it by choice) would only somewhat negatively impact their likelihood of participating (M=5). Overall, they felt very confident in their ability to use SMS in general (M=7), and in their ability to use it specifically for research (M=6), and not very anxious about using SMS in general (M=2). They felt somewhat anxious about participating in SMS research (M=4). They generally had a moderately positive general attitude toward SMS in general (M=6), and toward using SMS for psychological research (M=4).

Both general and specific self-efficacy were negatively correlated with age (ρ=-.20, p=.001 and ρ=-.27, p<.001), indicating that older participants had lower self-efficacy for both SMS usage in general, and specifically for research using SMS. Similarly, both general and specific attitude toward SMS were negatively correlated with age (ρ=-0.24, p=.001; ρ=-0.36, p<.001), indicating that attitudes toward SMS in general, or for psychological research, became less positive with age.

To fit the expectancy model, Bootstrapped Bayesian structural equation modelling with diffuse priors and a random walk MCMC algorithm were undertaken in SPSS AMOS 22. Initially, two separate models were constructed: one for every day attitudes toward SMS, and one for attitudes specific to SMS as used for psychological research. The potential impact of age as a mediator was examined on a path-by-path basis. For all paths, the addition of age as a mediator for each path in the model universally worsened model fit (as indicated by a larger DIC). The potential impact of age as a predictor of each node was similarly examined on a node-by-node basis. For all variables, the addition of age as a predictor universally improved model fit. The final model for adult data was constructed with general expectancy-based concepts predicting their SMS-for-research specific counterparts, and age serving as a predictor of all nodes in the model (Figure 1, Table 1).

General expectancy-based concepts were all significantly positively associated with their specific counterparts, supporting the hypothesis that expectancies about general SMS usage are a meaningful predictor of expectancies about the use of SMS as a tool for psychological research. Though regression weights were uniformly small, age was significantly negatively associated with all variables in the model, except for general and specific anxiety. This indicates that, overall, increasing age in the adult sample is associated with lower self-efficacy and a more external locus of control, and thus a less positive attitude toward using SMS in general, and specifically using SMS for psychological research.

Participation behaviour. The final question in the adult questionnaire was an invitation to actually participate in research using SMS. Two thirds of the adult participants provided their mobile telephone number, but only 11% (n=30) of the total adult sample responded to the SMS questionnaire. Analyses began with rare events logistic regression (as implemented in R by Imai, King and Lau, 2014), but because the same conclusions were reached with normal logistic regression, and over-dispersion was only moderate across calculations (ϕ between 1 and 1.2), coefficients from normal logistic regression are reported.

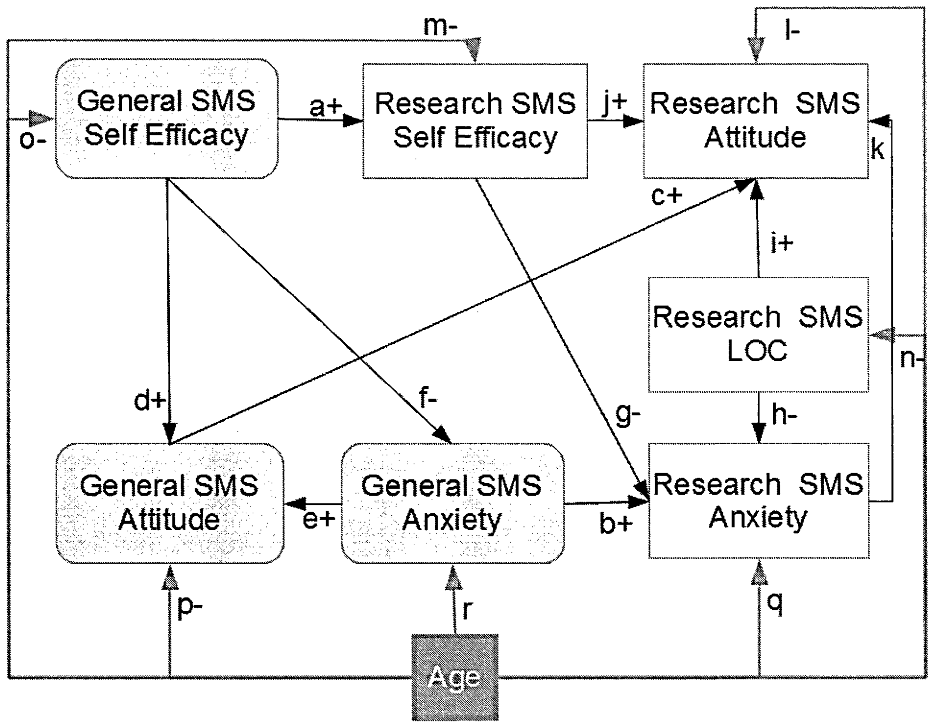

Figure 1. Structural diagram for the expanded expectancy model for adult data. This structural diagram depicts the expected relationship between general and research-specific attitudes, locus of control, self-efficacy, and anxiety. The letters describe the paths, and the + or – denotes whether a positive or negative association is expected. The square white boxes show how the model predicts how people will perceive SMS in a research context. Here, it is expected that anxiety will be associated with lower LOC (path h) and worse attitude toward SMS use for research purposes (path n); and that LOC and self-efficacy will be associated with a more positive attitude toward SMS for research purpose (paths i and j). The same relationships regarding perceptions of SMS usage in general are described by the rounded grey boxes. Perceptions of attitudes in general are considered predictors of attitudes toward SMS used for research, shown by paths leading from the rounded grey boxes to their corresponding square white box counterparts (paths a, c, and b). Finally, age is thought to be associated with all of these concepts, hence paths m, o, p, r, q, n, and l.

Those who gave their mobile number had a significantly higher internal locus of control (b=.502, SE=0.082, p<.001), level of self-efficacy (b=.18,SE=.03,p<.001), lower anxiety (b=-.016, SE=.038, p=.005), and more positive attitude (b=.16, SE=0.03, p<.001) relating to using SMS for research than those who did not provide their mobile number. Statistical comparison of those who did and did not respond once they had provided their number on most variables was not possible due to the small sample size, however the one stable model showed that there was no significant difference between respondents and non-respondents in terms of locus of control.

Table 1. *Coefficients for the expanded expectancy model*

	b	95% CI (L)	95% CI (U)	PP	DIC
				0.5	7646
General self-efficacy -> Specific self-efficacy (path a)*	0.905	0.737	1.075		
General anxiety -> Specific anxiety (path b)*	0.57	0.47	0.671		
General attitude -> Specific attitude (path c)*	0.855	0.534	1.175		
General self-efficacy -> general attitude (path d)*	0.349	0.272	0.426		
General anxiety -> general attitude (path e)	0.001	-0.047	0.05		
General self efficacy -> general anxiety (path f)*	-0.519	-0.689	-0.348		
Research self efficacy -> research anxiety (path g)*	-0.08	-0.175	0.014		
Research LOC -> research anxiety (path h)*	-0.252	-0.431	-0.075		
Research LOC -> research attitude (path i)*	1.359	1.135	1.581		
Research self efficacy -> research attitude (path j)*	0.125	<.001	0.251		
Research anxiety -> research attitude (path k)	-0.005	-0.129	0.121		
Age -> Research attitude (path l)*	-0.051	-0.087	-0.015		
Age -> Research self efficacy (path m)*	-0.073	-0.105	-0.042		
Age -> Research LOC (path n)*	-0.051	-0.07	-0.033		
Age -> General self efficacy (path o)*	-0.041	-0.063	-0.02		
Age -> General attitude (path p)*	-0.024	-0.036	-0.012		
Age -> Research anxiety (path q)	-0.003	-0.031	0.026		
Age-> General anxiety (path r)	-0.032	-0.063	<.001		

Note. * indicates significance at $\alpha=0.05$. The Deviance Information Criterion (DIC) is a hierarchical generalization of the Akaike information criterion and Bayesian information criterion (AIC and BIC), and is interpreted in the same "smaller-is-better" manner. It cannot be calculated in situations with non-numeric (i.e. binary) data, so the Posterior Predictive (PP) is reported where models include binary outcomes. The Posterior Predictive essentially compares the actual values of the data against the values the model would predict. A Posterior Predictive value of .5 indicates good model fit, whilst anything approaching 0 or 1 indicates poor model fit.

Discussion

Commensurate with the literature, approximately a half of children and all adults owned a mobile telephone (ACMA, 2013; Downie & Glazebrook, 2007; Inyang et al., 2010). Promisingly for researchers hoping to capitalise on the opportunities SMS offers, most participants had at least some experience with using SMS, and felt positively about its impact in their daily lives. Though most had no experience with using SMS in a research context, adults generally had a positive attitude toward using SMS in this new way, while children were more ambivalent.

Despite expectations based on parental oversight of child mobile use, and elderly dependence on adult children for mobile purchase and instruction on its use, internal locus of control for SMS usage was consistent across all ages. However, increasing age was associated with a higher sensitivity to external locus of control. This suggests that most participants were confident in their capacity to control their own SMS usage, and increasing age was associated with greater sensitivity to external threats to that control. When working with an older adult sample, researchers should consider offering SMS as a potential response mode, rather than imposing it on participants.

Age was negatively associated with self-efficacy in both the child and adult samples, though likely for different reasons. The children had relatively high rates of self-efficacy regarding using SMS as a tool for research, despite just under half not owning mobile phones. The decrease in self-efficacy as children got older is possibly due to a general self-efficacy over-estimation in younger children, which diminishes with age and experience (Pajares & Schunk, 1995). It would be educative for future research to measure both self-reported self-efficacy and actual performance in an SMS-based task in children. If such investigation finds an age-related overestimation of self-efficacy, a researcher considering using SMS to collect data from young children should be cautious when evaluating children's self-report of capacity to use SMS for research purposes.

The decline in self-efficacy with age in the adult sample follows the wider computer engagement literature (Lam & Lee, 2006), yet it was not accompanied by a parallel decline in actual SMS usage. Mobile telephone ownership was ubiquitous across all ages, and there was no association between the self-reported number of SMS sent per day, and age. This is congruent with findings that the elderly do use SMS (Lobet-maris & Henin, 2002; Mallenius et al., 2007). A significant decline in self-efficacy, but not SMS usage, suggests an age-associated discrepancy between self-perception and actual capacity. In a research setting, this may result in older participants spuriously avoiding of SMS-based research because they feel they would not be able to participate.

Children and adults were not particularly anxious about the prospect of using SMS to respond to researchers. Increasing age was significantly associated with lower anxiety in the child sample, possibly because older children have more SMS experience. This is similar to findings that experience is inversely related to anxiety in the computer anxiety literature (Chang, 2005). Despite computer anxiety studies showing a relationship between anxiety and age (Dyck & Al-Awar Smither, 1994;

Laguna & Babcock, 1997), the current study found no association between age and anxiety in the adult participants.

Mahatanankoon and O'Sullivan (2008)'s expectancy model was a useful framework for guiding discussion of attitudes toward SMS in everyday life, and specifically as a tool for self-report research. Locus of control, self-efficacy, and anxiety were all significantly related to attitude. Yet, attitude was not significantly associated with actual response behaviour; comparatively few participants provided their mobile number, thus volunteering for a follow-up study to be administered via SMS. The expectancy model distinguished those who did provide their mobile number from those who did not, but was not helpful in distinguishing those who subsequently responded to the SMS-based questionnaire from those who did not. This may indicate that these locus of control, self-efficacy, and anxiety are associated with behavioural intention to participate in research via SMS (i.e. volunteering a mobile number), but not necessarily actual participation behaviour (i.e. responding via SMS with answers to a researcher's questions).

General discussion

Both the qualitative first study, and quantitative second study, suggest that attitudes and behaviours surrounding SMS usage in everyday life are significantly associated with attitudes and behaviours relating to using SMS as a tool for self-report data collection. However, study 2 did not find that everyday SMS usage behaviour (number of SMS sent per day) was associated with actual participation in SMS-based research. This supports the practise of using everyday attitudes as an indicator for attitudes specific to SMS, but suggests that everyday SMS usage behaviours are not a valid source of information for guiding whether SMS may be appropriate for use with a particular sample group. Shortcuts such as turning to pre-existing information regarding attitudes toward SMS in general should not be used as a substitute for the more focussed, if effortful, approach of conducting prospective feasibility studies focussing on the applicability of using SMS with a specific target population (such as Broderick et al., 2012; Haberer, Kiwanuka, Nansera, Wilson, & Bangsberg, 2010).

The expectancy model provided an insightful framework for predicting behavioural intention - participants who volunteered to participate in research using SMS had a significantly higher internal locus of control, self-efficacy, lower anxiety, and more positive attitude toward using SMS for research than those who did not. However, very few participants actually responded to the SMS questionnaire, and neither age nor any element of the expectancy model distinguished those who did from those who did not respond. The discrepancy between provision of mobile number, and actual participation, is a clear demonstration of the behaviour-intention gap described in the theory of reasoned action (Sheppard et al., 1988), which is also present in other domains of technology usage (Wu & Du, 2012).

It is beyond the scope of this paper to dig too deeply into the case of this behaviour-intention gap (for an informative review, see Sheeran, 2002), but there are some avenues for diminishing the gap for self-report research conducted via SMS that future research could evaluate. Setting a concrete plan can improve the likelihood of intention translating into behaviour (Carrington, Neville & Whitwell, 2014; Norman & Conner, 2005), so perhaps a research participation plan, including upfront information about what questions will be asked, how responses will be formatted, and when SMS will be sent would promote responses. Another tactic would be to diminish the delay between recruitment and active participation as much as possible, as longer delays are associated with higher non-response rates (Walsh, & Brinker, 2015). Further research clarifying these and other mechanisms underlying this gap between attitudes and response behaviour could prove an invaluable tool for improving response rates in future application of SMS as a tool for communication with participants.

A major strength of the current studies was the use of a wide cross-section of age groups, rather than isolated groupings of ages. Doing so allowed insight into the potential of using SMS to conduct research with a previously largely overlooked group – older adults. The current study supported the proposition that the elderly do use SMS (Lobet-maris & Henin, 2002; Mallenius et al., 2007), but also that older adults tend to use SMS less frequently than younger adults (Ling, 2008b; Smith, 2011). Reflecting the general trend that older individuals tend to prefer traditional methods of data collection such as voice calls (Theiler et al., 2007), increasing age in the current study was associated with a less positive attitude toward using SMS for psychological research. Yet, this does not necessarily indicate that SMS cannot be used with older samples at all. The age-associated change in attitudes toward using SMS for self-reported research was largely a transition from a positive to a neutral attitude. These results provide no basis for assuming that the elderly are unsuitable participants for research conducted via SMS by virtue of their age alone. Because the focus of the current study was on attitude, a number of age-related characteristics that could impact on the capacity of the elderly to use SMS, such as such as poor eyesight, or reduced hand-eye coordination, were not measured. The impact of these changing physical capabilities may have been artificially minimised in the current study though potential selection bias – unhealthy older adults would be less likely to sign up for interview-based research, and only adults with sufficient eyesight and hand-eye coordination to use a computer would have been able to respond in study 2.

It is important to note that this study was a cohort design. Consequently, this study cannot comment on how attitudes toward SMS may change over the life span. There is evidence that SMS usage is somewhat a life phase phenomenon. Analysing several cohort studies, Ling (2010) notes SMS usage peaking around the late 20s and diminishing in adulthood within individuals. The age-related purposes for SMS usage reported in the literature (i.e. social use in teenagers, versus personal safety in the elderly) have not changed much over years of investigation (Devitt & Roker, 2009; Ling, 2002, 2010). However, the timing of this study constitutes a snapshot of the tail end of the rise of SMS ubiquity, and examines a population with differential exposure to SMS. Child and young adult participants have not known a world without SMS, while elderly participants will have first encountered SMS relatively late in life. Some age-based differences, particularly the low self-efficacy of older individuals, are likely to diminish as time progresses and the SMS savvy young adults of today become the elderly of tomorrow.

This paper investigated the possibility that attitudes and behaviours surrounding SMS usage in everyday life can be used as an indicator for attitudes and behaviours relating to using SMS as a tool for self-report data collection. Attitudes relating to general SMS usage were meaningful predictors of attitudes toward using SMS for the purposes of research. Increasing age was associated with lower self-efficacy and a less positive attitude toward using SMS in general, and specifically using SMS for psychological research. However, attitudes were not significantly associated with actual participation behaviour.

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SMS4Deaf – SMS as a mode for psychology research with the Deaf

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SMS4Deaf – Self-report Reflections on SMS as a Mode for Psychology Research with the Deaf

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Abstract

Purpose: Text messaging (Short Messaging Service, SMS) is ubiquitous in Australia. It may prove a cheap and convenient method allowing bidirectional communication between participant and psychological researcher. A strength of applying SMS as a research tool is its inclusiveness, as it may be used to communicate with both hearing and deaf participants. This paper explores how the Australian deaf community engages with SMS, and how this engagement may be applied to using SMS to communicate with deaf participants in a psychological research setting.

Methods: Sixty six hearing impaired participants aged 20-89 years, ranging from moderately to profoundly deaf took part by way of questionnaire (paper, online text, or online Auslan translation). At the end, they had the option to provide their mobile number and be sent a questionnaire via SMS.

Results: Most participants owned mobile phones, and used SMS daily. 60% believed that using SMS for research is a good idea. However, this did not translate into volunteering to participate in research using SMS – of the half who provided their mobile telephone numbers for subsequent participation, there was only a 17% response rate. Pearson's Chi-squared tests, Spearman's correlation, and logistic regression did not reveal any significant differences between those who did and did not offer their mobile telephone number in terms of mobile ownership, daily SMS usage, degree of deafness, or confidence with written English.

Conclusions: Though many indicated willingness to participate in research via SMS by providing their mobile numbers, a very low response rates to SMS questionnaires indicates that SMS may not be the most engaging method for research with this sample.

Keywords: SMS; Text messaging; Mobile telephone; Deaf

Introduction

Text messaging (Short Messaging Service, SMS) heralds an important opportunity for psychology researchers. It may prove a cheap, convenient, bidirectional communication tool between participant and psychological researcher. Its greatest strength is the ubiquity of mobile telephone ownership and usage in Australia [1], allowing unprecedented access to participants throughout the course of the day, with minimal disruption to their thoughts and behaviours. The potential for SMS as a means of communicating with deaf participants is of particular social importance as a mainstream [2] portable communication medium and the first mobile telecommunications technological advancement that has truly connected people across the divide of hearing and hearing impaired [3,4]. SMS is a research mode with the added benefit of communicating with both hearing and deaf participants in the same research and in the same way. The current paper evaluates the potential for SMS as a tool for research with the deaf community. Following an exploration of factors that may impact upon mobile telephone ownership and usage within the Australian deaf population, current SMS language and usage in the deaf community is investigated to inform how SMS communications should be phrased in a research context. A final important consideration is whether the deaf community endorses SMS as a psychological research mode.

Since its introduction, SMS functionality has been a major factor in the proliferation of mobile phone ownership in Australia [5]. Australian SMS usage has been increasing dramatically, with 20,205 million SMS sent in 2005 increasing to 36.3 billion sent in 2011 [1,6]. Mobile phones, and their SMS functionality, are readily adopted by deaf individuals, as well as their immediate family and support network [3,7]. Uptake of SMS outstrips that of other text-based communication options, such as email or instant messaging, in deaf communities [2]. Many deaf people buy a mobile telephone solely for its SMS functionality [8]. In Australian research targeted at the larger deaf community, over 90% owned a mobile telephone [3], and over half of that sample listed SMS as the most useful aspect of their mobile phone. In 2004, SMS usage was estimated to be higher in the deaf than in the hearing population [7]. As in the wider non-deaf Australian population, SMS is used more frequently by the younger demographic of teenagers and young adults [2]. Aside from the benefits of SMS often cited in research with non-deaf participants including its availability, portability, convenience, cost-effectiveness and ease of use [2,3,9], SMS is uniquely useful to deaf individuals for communications typically carried out by voice call including hailing taxis, contacting roadside assistance for breakdowns, and coordinating purchases and banking [3]. This high mobile ownership and SMS usage in the deaf community strongly suggests that this population in general does indeed have the capacity to participate in psychological research by way of SMS.

Participant age is one factor commonly associated with mobile ownership and SMS engagement [10-12]. An additional issue specific to the deaf community is the point in time in which hearing was lost in terms of language acquisition: pre-lingually (at birth, or before age 3), or post-lingually at a later time in life. Pilling and Barrett [2] found that pre-lingually deaf individuals were significantly more likely to use SMS than post-lingually deaf individuals, especially if a signed language was their preferred language. The structural similarity between Australian sign language and SMS in terms of brevity and grammar [7] might underlie the relationship between a preference for signed language and greater SMS usage. Pilling and Barrett [2] do note that the relationship between SMS usage and whether participants were pre- or post-lingually deaf may be an age effect, as they also found that older individuals used SMS less, and their sample contained a disproportionately low number of pre-lingually deaf participants in older age groups (50+). The current study investigates whether age is a confounding factor in this relationship by controlling for age, and comparing pre- and post- lingual deaf individuals in a younger age bracket. It is hypothesized that, particularly those aged 25 or under, SMS usage will be higher among those who were pre-lingually deaf than those who are post-lingually deaf, and SMS usage will be higher among those who state sign language as a primary or preferred communication option than those who do not.

In older adults, the time point of hearing loss is significant in terms of exposure to other text-based communication methods. Participants aged 25 or under at the time of writing the current paper would have been no more than ten years of age when SMS functionality was introduced in Australia, so it may reasonably be assumed that SMS has always been a choice for text-based portable communication for this group. Adults aged 30 and over who were born deaf, or lost their hearing, before 1995 were exposed to text-based communication methods other than SMS, in both static and mobile forms. The Teletypewriter (also known as TTY), was a text-based communication system developed specifically for the deaf in the 1960s [7]. Deaf individuals were first exposed to text-based mobile phone communication system in the late 1980s with the introduction of early mobile phones, which were capable of acting as TTY terminals. This was short lived, as the analogue telecommunications network that supported this was completely phased out in favour of a digital network system in 2000 [8]. The demise of mobile TTY was ameliorated by the introduction of SMS in Australia in 1995, during the transition from analogue to digital infrastructure. TTY, and the National Relay Service, is still in use by way of desktop TTY machines. As noted by Pilling and Barrett [2], there is less impetus to learn SMS when an adult is already using a technology that fulfils the same role. It may be that older individuals who lost their hearing prior to 1995 would have been less motivated to making the transition to SMS than those who lost their hearing after 1995, as they were already using TTY. It is therefore hypothesised that in deaf Australian adults aged 30 and over, SMS usage will be associated with the point in their life when they lost their hearing, even when the relationship between SMS usage and age is controlled for. Specifically, those who lost their hearing after 1995 are more likely to own a mobile telephone, and use SMS more frequently, than those who lost their hearing prior to 1995.

This is helpful to researchers wondering who amongst the Australian Deaf community may communicate with psychology researchers by way of SMS. Another important issue is how it should be done. One of the primary distinctions between SMS and other communication methods is its brevity, which in turn leads to a specific style of language. Text speak is a dialect of written English that creatively reinvents words according to the need for brevity enforced by the 160 SMS character limit. These reinventions often rely on "alphanumerish", the phonological similarity between text and numbers, e.g. the similarity between the sound of the number "8" and the word "ate". Given that additional length can increase the cost of sending an SMS, a researcher working to a budget should establish whether these shortenings are common in everyday SMS usage within the deaf community, and thus can be used to minimise the cost of conducting research. Power et al. [3] noted that phonologically based abbreviations might be difficult for deaf people to interpret. This suggestion assumes lack of exposure to the sound of written words, and so could be demonstrated by comparing those individuals with mildly impaired hearing (who can hear some speech) to those with profound deafness (who cannot hear any speech whatsoever). It is hypothesised that profoundly deaf individuals will have more difficulty interpreting phonological similarity-based SMS abbreviations than moderately deaf individuals, and that pre-lingually profoundly deaf individuals will have more difficulty interpreting phonological similarity-based SMS abbreviations than post-lingually profoundly deaf individuals. This is not to say that deaf individuals will use fewer of all classes of abbreviations. Indeed, it is likely that signing deaf individuals will have their own repertoire of abbreviations when using SMS.

Whilst brevity in sign language is best conceptualised as the minimisation of movement rather than word length, common movement shortening practises in Auslan (Australian Sign Language) are akin to abbreviation in written English. Examples of this include lexicalised finger spellings, finger spelling abbreviations, and single manual letter signs [13]. Lexicalised finger spellings are the repetition of single letter signs in order to represent full words (i.e. T-T for Toilet, or D-D for Daughter), or finger spellings of abbreviations (i.e. J-A-N for January, or A-D-V for Advertisement). Single manual letter signs are where the first letter of the English word is used instead of the whole word, i.e. W for Week, or Y for Year. It is therefore hypothesised that signing deaf individuals will employ initialisms, stemming from lexicalised finger spelling, and single manual letter sign abbreviations in their SMS.

A final and important consideration when discussing the possibilities of any research with the deaf community is their opinion of the medium. Participant perception of a research mode is instrumental in its success or failure when used for research [13]. Just as everyday SMS usage forms an informative baseline for researchers considering its usage as a mode for research; it may be that everyday SMS usage will inform participant opinions regarding the use of SMS in the capacity of psychological research participant. SMS should also be explored in the context of other research modes, such as paper, online, or email communication to delineate general opinion of usefulness and preference. It is hypothesized that a higher self-reported use of SMS, and a more positive attitude toward using SMS for research, will be associated with a greater likelihood of volunteering to participate in SMS research.

Methods

Participants

Over the course of six months, participants were recruited through the following organizations and groups, primarily by way of an email being forwarded to group members: Canberra Deaf Club; Deafness Forum; Deaf Australia; Better Hearing; Sydney Cochlear Implant Centre; DeafCanDo; Deafness Resource Centre; Victorian Deaf Society; Western Australia Deaf Society; ASLIA; Able Australia; Deaf Society of NSW; the Shephard Centre; the ACT Deafness Resource Centre; and, on Facebook: Auslan Matters; Canberra Deaf Club; and I'm just deaf, not an alien! The only inclusion criterion was that participants had to be deaf to some degree. Consent was implied by return of survey, and no incentive for participation was offered. The final sample consisted of 66 participants, aged 20-89 (Mean age=47), 60% were female.

Materials

This study consisted of an initial questionnaire, followed by an optional SMS component. The questionnaire was created for this study, and included demographic questions relating to gender, age, hearing status, preferred language, mobile phone ownership (whether one or more mobiles were owned, and whether that mobile was a smart phone) and text messaging usage in terms of average SMS sent per day. To give context to this, participants also reported how often (never, daily, weekly, or monthly) they used their mobile telephone for other purposes, such as voice calls, email, music players, or as a clock to tell the time. Participants were asked to rate their written English confidence in general, and then their written English confidence specifically when using SMS, on a sliding five point scale from 'not at all confident' to 'very confident'. There were then three primary lines of inquiry, with participants asked to respond in both single-option choices (i.e. good/bad, yes/no) for quantitative analysis, and open-ended text boxes for a qualitative response.

Would you rather complete a questionnaire via SMS, email, or post?

Do you think using SMS for research is a good or bad idea?

Is SMS good for Deaf people? Why or why not?

The next questions referred to text speak, specifically asking whether participants find it difficult to read, and which forms of text speak they themselves use. Participants were presented with a list of forty commonly used text speech phrases drawn from. The questions concluded with an invitation to complete follow-up questions via SMS, where participants willing to do so provided a mobile number. This was used as a behavioural measure of willingness to participate in research via SMS.

This questionnaire was distributed in three forms - a paper response to be posted to the researcher, online questionnaire with questions written in English, or online questionnaire with questions presented as an embedded video of an Auslan interpreter (one video per question). Participants could choose which form they wished to respond to. Equivalence could not be statistically evaluated due to highly unequal number of responses in each form - the majority (84%) participated using the online version, 15% to the video version, and only one participant responded by paper. Data from the three response forms were pooled for analysis.

The SMS portion of the study consisted of the 20-item, 7-point likert scale Ruminative Thought Styles (RTS) questionnaire, and follow-up questions asking for ratings of how clear the RTS instructions were, and how physically difficult it was to type responses to the SMS, on a 5-point likert scale.

Procedure

This study involved a self-report online survey, and behavioural outcome component. Participants were presented with information about the study, and invited to participate by completing the correlational questionnaire either online (in English or Auslan formats), or by post. Those who indicated willingness to participate in the SMS component provided their mobile telephone numbers via this survey. The SMS component occurred within a week of completing the questionnaire, beginning with an initial text scheduled for arrival at 2:00 pm in order to control for the possible effect that time of day might have on response rates, or response delay. This initial text was followed by four more SMS scheduled to arrive at 2:15 pm, each containing five of the RTS items (because the whole 20 items cannot fit into a single message), and a fifth the following day at 2:00 pm containing follow-up questions about the RTS instruction clarity and ease of responding.

Statistical analysis

The majority of the current data is categorical in nature, or not normally distributed, leading to the use of non-parametric alternatives to more commonly used statistics. Spearman's rank correlation coefficient (denoted in text as ρ) is a non-parametric measure of correlation. It provides measure of the degree of relationship between two variables, and is more robust against violations of normality (allowing non-normal and discrete distributions) than the more commonly used Pearson's correlation coefficient, which is not used in the current paper. Similarly, the Wilcoxon signed-rank test is a non-parametric alternative to the t-test, used when the underlying variable of interest is not normally distributed. It is denoted in text as W.

Logistic regression models the relationship between an independent variable (that may be categorical or continuous) and a binary dependent variable. This relationship can be expressed as an Odds Ratio (OR), which is the ratio of the odds of an event occurring to it not occurring. Logistic regression models are particularly helpful when a causal, continuous predictor is to be examined. However, where causality is not of interest, and one wish to test if two categorical variables are significantly related, a chi-square test is more appropriate.

Pearson's Chi-squared test is a method for analysis of categorical data where a chi-square distribution approximating the data is used to test the null hypothesis that the observed data could have occurred by chance. It does not comment upon the causal aspects of that relationship, but is useful in correlational designs like the current study. Given the relatively small sample size available for analyses, the size of some cells in several chi square tests was quite small (n less than 5). This can be problematic as it threatens the reasonableness of using a chi-square distribution to approximate the discrete distribution of the test statistic. In these cases, monte carlo p value simulation will be used. This involves simulating randomly generated samples with the same n in accordance with the hypothesis being tested to produce a reference distribution, and deriving conclusions from this [14-16].

For open-ended responses, emerging themes were read by the researcher and coded in the style of a grounded theory approach to extract categories from the data. Two independent raters then counted incidences of those common themes. Agreement between researchers was quantified by way of a square weighted Kappa statistic. This gives an indication of agreement between observers, on a scale of 1 meaning perfect agreement, .5 meaning half agreement, and 0 meaning chance level agreement.

Results

All 66 respondents were included in analysis. The majority (88%, n=59) had lived in Australia their whole lives. Forty five percent (n=30) reported English as the language they used most each day, 47% (n=31) using Auslan most, and 8% (n=5) using another language (New Zealand Sign Language, British Sign Language, and lipreading) most. Most (68%, n=45) of participants were profoundly deaf, with only 3% (n=2) of participants reporting they could easily hear a spoken conversation, 5% (n=3) were moderately deaf, and 24% (n=16) were between moderately and profoundly deaf. 58% (n=39) of participants were pre-lingually deaf (all of which from birth), while 42% (n=27) were post-lingually deaf. Post-lingually deaf individuals had been deaf between 3 and 72 years, (Mean=33, SD=18). Refer Figure 1 for a breakdown of year reported Deaf, in the context of the historical progression from TTY to SMS.

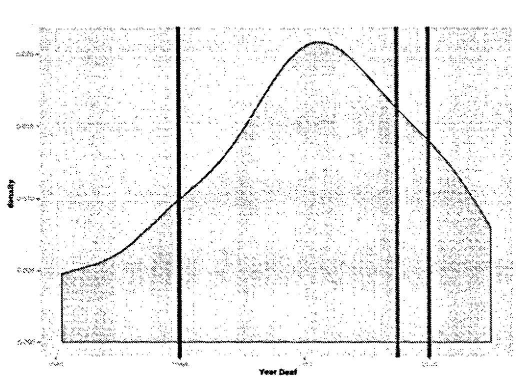

Figure 1: Density plot of the year of Deafness onset in individuals not born Deaf. The boundary marked by lines indicates meaningful events in text-based communication availability; 1960, when TTY was first introduced (black); 1995, when the national relay service for TTY was established (grey, left); and 2000, when support for TTY on mobile handsets was abolished by a move to digital infrastructure (grey, right).

Daily mobile usage in the australian deaf community

Most (97%, n=64) of the sample owned a mobile phone, with 23% (n=15) owning a cell phone, 8% (n=7) a web phone, and 66% (n=44) a smart phone. Those who reported owning a mobile were experienced mobile users, having owned a mobile for up to 15 years, with an average length of mobile ownership of 12 years. Spending between $0 and $200 (Mean=$48, SD=$30) on mobiles per month, participants were active users of their mobile phones for a variety of purposes. While the majority (67%, n=44) of participants reported never using their mobiles for voice calls (6% reported using mobiles for voice calls monthly, 14% weekly, and 13% daily), most used their mobiles daily for email, and to tell the time (72% [n=48] and 78% [n=52] respectively). A fair number (64%, n=42) also used their mobiles for other purposes on a daily basis, including browsing the internet, banking, as an alarm, and communicating with non-signing people via written notes.

Only one participant reported they never used SMS, with the vast majority (91%, n=60) stating they used SMS on a daily basis. Participants reported a daily average of sending between 0 and 200 (Mean=16, SD=27) SMS per day. Over half of participants were confident in their written English ability in general, and more were confident in their written English ability in terms of SMS (62% [n=40] and 70% [n=46] respectively). As would be expected, there was a significant correlation between confidence in written English in general, and written English for SMS (ρ=0.77, p<0.00). Eighty six percent of participants believed that SMS was good for Deaf people in general. Five themes emerged from corresponding open-ended question asking why this is so: convenience, social factors, cost, communication, and other (Table 1).

Theme	Count	Kappa	Example responses
Convenience	27	0.97 (p=<0.01)	"SMS is very convenient for deaf people and very mobile! Can be use anywhere and anytime!"
Social factors	19	0.96 (p<0.01)	"Yes its easy to communicate and keep in touch with friends and family."
Cost	3	1 (p<0.01)	"Good and bad / Good as sms is quick and effective. / Bad with increasing number of words comes with increased costs."
Communication	50	0.95 (p<0.01)	"Yes of course it perfect for deaf community used sms as we can't used voice so sms help us to contact each other like going out, workplace, some doctor or dentist also nabs to book an interpreter! if no sms what can we do in our world?"
Other	13	1 (p<0.01)	"Yes in case of emergency, tty is not mobile."

Table1: Count refers to n of individuals who mentioned this theme in their open-ended response. In the interests of readability, counts are only reported for observer 2. The accompanying square weighted Kappa statistic gives an indication of agreement between observers, on a scale of 1 meaning perfect agreement, .5 meaning half agreement, and 0 meaning chance level agreement.

The hypothesis that in deaf individuals, particularly those aged 25 or under, SMS usage would be higher in post-lingually deaf and those who preferentially use sign languages was not supported. Neither pre- or post- lingual onset of deafness, nor preference for signed languages over English, significantly associated with self-reported SMS usage on a daily basis across the whole sample (W=219 p=.45 and W=328 p=. 62, respectively) or in individuals aged under 25 (W=8, p=.315 and W=9, p=.359 respectively). Chi square tests with monte carlo p value simulation of self-reported confidence in written English for SMS was not significantly associated with preference for English or a signed language ($\chi 2$ =4.10, p=.14), or pre- or post- lingual Deafness ($\chi 2$ =.47, p=.90).

The hypothesis that in deaf Australian adults aged 30 and over, SMS usage will be associated with the point in their life when they lost their hearing, even when the relationship between SMS usage and age is controlled for, was not supported. First, the relationship between age and SMS usage was explored in the 55 participants aged over 30. The prediction that those who lost their hearing after 1995 are more likely to own a mobile telephone was not statistically examinable, as only two participants in the 30- and-older bracket did not own a mobile phone. Analysis of daily SMS usage proceeded with non-parametric tests, as Agostino tests revealed reported number of SMS sent per day was significantly positively skewed (z=2.5, p=0.01). Spearman's ρ revealed a significant negative correlation between age and number of SMS sent daily (ρ =-0.32, p=0.02), indicating that older individuals in the 30-and-older age group sent fewer SMS per day on average, than younger individuals in the 30-and-older age group. Turning to the point of deafness onset in this age group, just over half (56%) were Deaf before 1995. The vast majority of those Deaf before 1995 (84%), and after 1995 (91%) used SMS daily. Wilcoxen tests did not reveal a significant difference in average number of SMS sent per day between participants who were Deaf before, or after, 1995 (W=319, p=0.34; Figure 2).

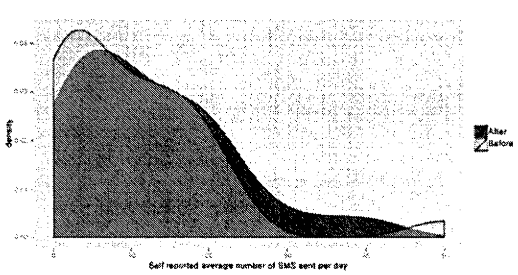

Figure 2: Density plot of the self-reported average number of SMS sent per day, grouped by whether individuals were Deaf before or after 1995, when the National Relay Service TTY was introduced in Australia.

Although 42% of participants said they find it difficult to read when people use text speaks, 55% said that they used abbreviations or shortenings when sending SMS. Reasons given by those who did not use abbreviations included a general dislike for abbreviations, self-confessed linguistic pedantry, and abbreviations being "overrated". Those who did not use abbreviations were conscious of their common use in SMS ("I don't use abbreviations, I'm sure I drive everyone mad!"), and some demonstrated a willingness to learn because of this ("I do not use the abbreviations when sending an SMS. However I'll learn more about it if they are becoming frequent to be used", "sometimes it is hard but when you learn you get used to it. Even hearing children use abbreviations/shortenings as it is cheaper and quicker.").

Across participants, 77 different text speak terms were reported as commonly used (Table 2). Though there were more examples of non-phonological than phonologically-based text speak (69% phonologically-based), the count of individuals using phonologically-based text speak was only slightly lower than the count for non-phonologically based text speak (47% and 53% of all occurrences of text speak usage respectively). The hypothesis that signing deaf individuals will employ lexicalised finger spelling, and single manual letter sign abbreviations in their SMS was not supported. The only recurrently used single letter signs were "c" and "u", both commonly used in the wider hearing Australian population [12].

Overall, participants correctly interpreted 67% of the SMS abbreviations they were presented with. Though correct interpretation count of phonologically and non-phonologically based significantly positively correlated (ρ=.80, p<.001), participants correctly interpreted significantly more non-phonological similarity based SMS abbreviations than phonological similarity based SMS abbreviations (W=1280.5, p<.001). While there was not a significant difference between the correct interpretation counts within subtypes of phonological similarity-based abbreviations, there was a significant difference within non-phonological similarity-based abbreviations, with participants correctly interpreting more contractions than shortenings (Table 3). There was no significant difference in correct interpretation of either shortening or contractions between individuals who preferentially used sign language rather than English (W=611, p=.35 and W=648, p<.114 respectively).

The hypothesis that pre-lingually profoundly deaf individuals will have more difficulty interpreting phonological similarity-based SMS abbreviations than non pre-lingually profoundly deaf individuals was not supported (W=198, p=.237). Similarly, the hypothesis that profoundly deaf individuals will have more difficulty interpreting phonological similarity-based SMS abbreviations than moderately deaf individuals was not supported (W=417.5, p=.451).

Txtspk	Meaning	Count	Type	Txtspk	Meaning	Count	Type
nurries	no worries	1	Stylisation*	plse	please	2	Contraction
2	to	5	Homophone*	thks	thankyou	1	Contraction
4	for	3	Homophone*	tmw	tomorrow	9	Contraction
&	and	1	Homophone*	tnt	tonight	2	Contraction
2day	today	3	Homophone*	txt	text	1	Contraction
2moro	tomorrow	1	Homophone*	ur	you're	2	Contraction
2morrow	tomorrow	1	Homophone*	wk	week	1	Contraction
2nite	tonight	3	Homophone*	wld	would	1	Contraction
b	be	3	Homophone*	yr	year	1	Contraction
b4	before	4	Homophone*	ystrdy	yesterday	1	Contraction
c	see	5	Homophone*	lol	laugh out loud	7	Initialism

cu	see you	3	Homophone*		people's names	1	Initialism
g8	great	1	Homophone*	T	today	1	Initialism
gr8	great	1	Homophone*	v	very	1	Initialism
l8	late	2	Homophone*	am	morning	3	Shortening
l8er	later	2	Homophone*	arvo	afternoon	1	Shortening
r	are	4	Homophone*	aug	august	1	Shortening
u	you	17	Homophone*	bro	brother	2	Shortening
w8in	waiting	1	Homophone*	def	definitely	1	Shortening
luv	love	3	N.spelling*	fri	Friday	1	Shortening
nite	night	1	N.spelling*	jan	january	1	Shortening
sum	some	1	N.spelling*	min	minute	1	Shortening
tix	tickets	1	N.spelling*	mon	Monday	1	Shortening
wot	what	1	N.spelling*	morn	morning	2	Shortening
fb	facebook	1	Acronym	oct	october	1	Shortening
ily	I love you	1	Acronym	pm	afternoon	1	Shortening
jmo	just my opinion	1	Acronym	poss	possible	1	Shortening
wtf	what the fuck	1	Acronym	re	are	1	Shortening
bck	back	1	Contraction	sat	Saturday	1	Shortening
bday	birthday	2	Contraction	sept	september	1	Shortening
brb	be right back	3	Contraction	sun	Sunday	1	Shortening
cnr	corner	1	Contraction	ta	thankyou	2	Shortening
cya	see you	2	Contraction	thur	Thursday	1	Shortening
hw	how	1	Contraction	tom	tomorrow	1	Shortening
msg	message	1	Contraction	tue	Tuesday	1	Shortening
n	and	2	Contraction	uni	university	1	Shortening
pls	please	1	Contraction	wed	Wednesday	1	Shortening

Table 2: Text speak reported as commonly used by the current sample, count being the number of individuals who reported using that particular text speak (as a proxy for commonality of use). * indicates text speak that is phonologically based; N.spelling is non-conventional spelling.

	Mean	SD	Skew z	Wilcoxen test	Correlations
(A) Phonological similarity 11.98	5.27	-1.527		A	a1
(a1) Letter/number homophones	6.52	2.26	-2.96*	W=2396 p=.317	-
(a2) Accent stylisation	5.47	3.52	-0.594		.67**
(B) Non-phonological similarity 14.98	5.25	3.259**		B	b1
(b1) Shortenings	6.97	2.77	-2.604*	W=1427 p<0.001	-
(b2) Contractions	8.02	2.74	-3.480**		.51**

Table 3: Summary statistics of count of correct interpretations of SMS abbreviations, grouped by linguistic type. Summary of Skew z refers to outcomes of D'Agostino skewness tests. * significant at p=.05; ** significant at p=.001.

SMS as a tool for research in the australian deaf community

60% of participants believed that using SMS for research is a good idea. Themes emerging from open-ended responses were speed, convenience, communication, and other (Table 4). There was some division in comments relating to the way in which SMS may be seen as a means of including the Deaf community in psychological research, as can be seen from these contrasting responses.

"Deaf people and people who have Auslan as their mother language should have their right to have each and every questions explained via Auslan. Text/SMS does not allow this therefore it is breaching their human right to have information in their language."

"I'm a staunch supporter of research and anything that may help the hearing impaired sounds like a good idea to me!"

Theme	Count	Kappa	Example responses
Speed	6	1	"Quick, questions are written"
Convenience	20	0.84	"My access everywhere and anytime !!"
Communication	24	1	"Can get to many more Deaf/HI people. Not all deaf access email or can read too well, so sms is useful"
Other	30	0.92	"As long as the result of the research is published and sent to deaf people."

Table 4: Count refers to n of individuals who mentioned this theme in their open-ended response to the question "Do you think using SMS for research is a good or bad idea?". In the interests of readability,

counts are only reported for observer 2, however the accompanying square weighted Kappa statistic gives an indication of agreement between observers. In the interests of brevity, Counts are reported for observer 2 only.

Interestingly, a number of participants indicated that the viability of SMS as a tool for research with Deaf individuals was dependent on the brevity of the response, due to issues of richness of communication and the pragmatic cost of sending long responses by SMS. Specifically, several stated that it would be suited to multiple choice style questionnaires.

"It could be useful for poll questions. Quick responses."

"for short research, fine... but long one, not too good idea"

"If it was only a couple of questions, then SMS may be ok. Email or link to on-line survey easier." "If its a short survey - ok ok.. But prefer to keep SMS for relevant correspondence not for other uses such as surveys - as it would mean extra charges for lengthy SMS."

"Good idea if questions are multiple choice only and does not require writing a response."

"If the research is entirely multiple choice, or questions requiring only once answer, then conducting the research via SMS would probably work well."

Given the choice of completing questionnaires via SMS, email, or by post, 85% of participants indicated they would prefer to use email, and 15% by SMS. Common themes emerging in open-ended responses were speed, physical difficulty of responses, cost, and other, are presented in Table 5.

Theme	Count	Kappa	Example responses
Speed	18	0.96	"It's quicker as the keyboard is larger and I check my emails several times a day."
Physical factors	44	1	"Easier for typing purposes. Screen on mobile too small."
Cost	4	1	"Cost too much to use mobile"
Other	22	1	"Extent of text available, less prone to mishearing. Record of what was said or not said."

Table 5: Themes mentioned by individuals asked "Would you rather complete a questionnaire via SMS, email, or post? What are your reasons?" Count refers to n of individuals who mentioned this theme in their open-ended response to the question. Example responses refer to those who nominated a preference to email, but counts are for themes mentioned across all nominated preferences. In the interests of readability, counts are only reported for observer 2, however the accompanying square weighted Kappa statistic gives an indication of agreement between observers. In the interests of brevity, Counts are reported for observer 2 only.

The majority of open-ended responses discussed the benefits of email rather than the detriments of SMS as a tool for psychological research. However, there were some indications that the intrusiveness SMS in their daily lives led to a concern with the potential for research.

"SMS is a pain in the arse. There is no way I can control it's intrusion into my time."

"Because SMS is an irritant. [...] day to day situations where SMS controls you, email is definitely the best way for me to manage my time."

The hypothesis that a higher self-reported use of SMS, and a more positive attitude toward using SMS for research, would be associated with a greater likelihood of volunteering to participate in SMS research was not supported. Positive or negative attitude toward using SMS for research was not significantly associated with whether or not participants gave their mobile phone number either as the sole predictor (OR=.47, z=-1.38, p=.16), or in a model with self-reported daily SMS usage (OR=.44, z=-1.45, p=.14). Similarly, self-reported daily SMS usage was not significantly associated with whether or not participants gave their mobile phone number either as the sole predictor (OR=1.01, z=.803, p=.42), or in a model with positive or negative attitude toward using SMS for research (OR=1.01, z=.59, p=. 553). These results should be interpreted with caution, as residual variance indicated that logistic regression model fit was poor overall (as indicated by significant deviance and likelihood ratio tests, χ^2 $p \approx 0.02$ for all discussed models).

Of the 30 individuals who provided their mobile telephone numbers for subsequent participation, there was a 17% response rate. Fourteen participants responded in some manner, but only five of those responses involved an attempt to complete the RTS. Though the sample of respondents is too small for statistical analyses, the follow-up information from those who did respond in some manner indicates that the low response rate was not due to difficulty typing the text to send the SMS response (only one participant found it very difficult to type the text to respond to the SMS, three found it somewhat difficult, and five very easy), or confusing instructions (four participants rated the instructions as clear, five as very clear). Responses such as "Hi i t is imposibl 4 me 2 remembr al questns 2 b able anser them" indicate that factors not measured by the current study, such as the size of participant's mobile telephone screen (and thus the amount of text that is visible at any given time), may impact on the participant's willingness and ability to respond to research SMS.

Discussion

In line with the findings of Power et al. [3] and Harper and Clark [8], mobile phone ownership and daily SMS usage was very high in the current sample. It may be that the dramatic uptake of SMS among the deaf population noted by Pilling and Barrett [2] has resulted in near saturation of daily SMS usage within the deaf community. The majority of respondents reported a positive view of SMS in daily life, affirming that, as in Akamatsu et al. [9] and Bakken [4], SMS is very important for communication, particularly as a means of bridging the communication divide between hearing and non-hearing people. This may be due to its convenience, also mentioned my many participants, as the portability of SMS renders it useful for situations where email or TTY are not available, but immediate text-based communication is required. Results were in line with observations in the broader literature that there are age based differences in mobile phone usage [10,11], with older individuals generally using SMS less than younger individuals [15]. Likely due to the sheer ubiquity of SMS usage in the current sample, there was no support for either hypothesis that current daily SMS would be related to historical point where individuals became deaf, in terms of linguistic development in those aged under 25 or the historical context of SMS development in those aged over 30, beyond age-based differences in SMS usage.

Predictions that the deaf community, particularly the signing deaf, would use text speak in an idiosyncratic way were not supported. Though around half of the current sample found text speak difficult to read, many participants used it, employing the same repertoire of text speak as the wider population [12]. Participant attributes such as pre- or post- lingual onset of Deafness, and degree of Deafness, did not significantly impact on correct rate of interpretation of phonologically based SMS abbreviations, though as predicted by Power et al. [7], participants were better at in interpreting non-phonologically-based abbreviations. Contrary to expectations, both signing and non-signing participants had significantly more difficulty interpreting shortenings than contractions. Though at face value contractions and shortenings seem similar, shortenings are more likely to have multiple interpretations than contractions, i.e. the shortening "mon" could be taken as either "month" or "monday", while the contraction "mnth" is more clearly "month". Context is an important factor in selecting the correct shortening interpretation. Given that participants reported using a number of shortenings in their everyday SMS behaviour, it is likely that the difficulty participants had with interpreting shortenings in the current study were due to their being presented context-free. Despite qualitative comments indicating a willingness to learn how to use abbreviations, and the relatively common use of text speech in everyday SMS activities, almost half of the sample indicated they found text speak difficult to read, and participant interpretation of SMS abbreviations illustrated several errors. It is therefore recommended that, in the interests of clarity, text speak abbreviations be avoided when using SMS as a tool for research with the Deaf community. If they must be used, then it is recommended that researchers only consider non-phonologically based types of text speak, preferably contractions, and possibly shortenings if the surrounding context renders their meaning clear.

Just over half of participants reported a positive view of using SMS as a tool for research with the deaf community, with the most notable caveat being that it is most suitable for research which is brief (e.g. polls, or short multiple choice questions). Open-ended responses referring to the speed with which participants could respond to the researcher were mentioned less than issues of convenience, and communication, notably, the inclusivity of SMS as a tool for research that may be applied to both deaf and non-deaf populations. The theme of inclusivity was mentioned by several participants, and it should be noted that not all viewed SMS as sufficiently inclusive, as it does not allow participants to use their first language, such as Auslan, when participating. It is important that researchers are aware of this cultural sensitivity, particularly when recruiting for Deaf participants when conducting research that uses SMS.

The majority of participants stated that they would rather participate in research via email, rather than via SMS, primarily due to physical factors such as the smallness of the mobile telephone screen, and difficulty of typing on a mobile compared to using a keyboard, and concerns about the potentially intrusive nature of SMS. This linked with many participants stating that it would be quicker for them to send an email response than it would be to send an SMS response. These issues are not unique to the Deaf sample, and may prove barriers in the general population. The physical difficulties of sending an SMS must also apply to using the mobile phone for email, something that a large portion of the sample reported doing daily, though email may be differentiated as it can be engaged with either on a mobile phone or a computer. It would be interesting for future research to disentangle email use per se, from email use specifically on a mobile, or on a computer, to fully explore the difference between email and SMS usage in a deaf sample. Very few participants mentioned cost as a factor in their response mode preference. A further theme emerging from open ended responses was control - participants cannot control when an SMS is received, but can control when to check their email, thus rendering email a less demanding and intrusive mode of communication. These results indicate that though SMS is a more positively perceived method of research communication than post, if a researcher has the option of using email or SMS to obtain data, particularly if they seek to collect data remotely in general, rather than moment data, email should be used.

This preference for email was not related to willingness to volunteer for participating in research via SMS. The hypothesis that a higher self-reported use of SMS, or a more positive attitude toward using SMS for research, would be associated with a greater likelihood of volunteering to participate in SMS research was not supported. The current study could not find any difference between those who did and did not provide their mobile numbers to complete follow-up questions via SMS. Promisingly, almost half of the sample provided their mobile telephone number to complete follow-up questions via SMS. Less promisingly, the response rate to the SMS questionnaire was very low. Further research is clearly needed to investigate why actual participation in SMS research was so limited. One possibility is that the timing of sending the SMS survey was inappropriate - future research may investigate this by sending the SMS survey at varying times of day and comparing response rates. Another possibility is that the SMS survey content was simply not interesting to participants. This could be investigated with pilot testing to identify topics of low and high interest specifically to the deaf community. Surveys of varying levels of interest could be matched for wording and length, administered, and response rates compared.

The current study had a number of limitations. Despite ongoing efforts to widen the reach of the survey via online, paper and Auslan alternate versions, the final sample was still relatively small. This in turn could have diminished the likelihood of finding significant relationships during analyses. Further, despite efforts to increase accessibility by offering an Auslan translation of survey instructions, the current survey methodology was limited in that it involved written responses, creating a possible selection bias for participants who felt their written English was of sufficient standard to participate. This was reflected in the generally high self-reported confidence in written English in the sample. This may result in higher levels of SMS usage in the current sample than the broader Australian deaf community, as a low standard of written English may both lower the likelihood of participating in a study such as this, and minimise usage of SMS. Whilst it is reasonable to assume that participants with insufficient written English skills to complete a paper or online survey will also have insufficient skills to complete an SMS questionnaire, results from the current study can only be interpreted as applying to the portion of the Australian deaf community with sufficient written English to participate in research which requires a written response, such as online, SMS, or postal studies.

Conclusion

Due to the ubiquity of mobile phone ownership, and common daily use of SMS in the current sample, these results tentatively support the assertion that there is the capacity within the Deaf community to participate in research via SMS. However, researchers should be aware that SMS is not necessarily a completely inclusive tool for research with the Deaf community due to its reliance on written English, which excludes deaf individuals with low literacy, and may raise issues of perceived discrimination against those who communicate primarily through Auslan. Given participant preferences for research modes, if a researcher is planning to undertake research using written English with the Deaf community, they should carefully consider whether email could yield comparable data. If SMS is to be used, researchers should avoid the use of text speak, and if they must use text speak due to message length or budgetary constraints, only use non-phonological abbreviations. Analyses indicated no particular guidelines on which portions of the deaf community may be best suited to volunteer for research via SMS, as the individuals in this sample who did volunteer to complete follow-up questionnaires via SMS could not be distinguished from those who did not on any expected criterion, including attitude toward SMS as a tool for psychological research, or demographic characteristics specific to the Deaf community. Despite the apparent potential of SMS as a tool for research stemming from its ubiquity in everyday usage, and inclusivity across the divide of hearing and non-hearing participants, the low response rates in the current study suggest SMS is not as viable as predicted with the Australian deaf community. Future research should explore whether the preference for email as a research mode within this community might translate into superior participation behaviour.

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Chapter 4: How should a researcher design an SMS self-report study?

Chapters 2 and 3 have shown that there is indeed the capacity for SMS to be used in self-report psychological research, from both a researcher and participant perspective. The next logical questions ask how SMS can be applied in a research setting, the quality of the data it provides, and how a researcher can design their studies to maximise data quality.

It is beguiling to jump straight to possible research topics or populations, and evaluate the data quality SMS provides, potentially in comparison to other modes (e.g. in Lim, Hocking, & Hellard, 2008; Suwamaru, 2012; Walsh & Brinker, 2012). Doing so is indeed an important part of investigating the properties of a research tool, and there is a growing literature outlining the varied topics and populations where SMS may be a useful tool (e.g. La Rue, Li, Karimi, & Mitchell, 2012; Lim et al., 2010). However, the literature's focus on the *topics* of self-report SMS research overlooks some fundamental considerations. This chapter focusses on the relationship between research design choices when using SMS to collect self-report information, and consequent participant retention, response rates, response delays, and data completeness.

To evaluate how a data collection tool performs, participants need to respond to the study in the first place. The previous chapter found that people were generally open the idea of participating in research using SMS, but there were worryingly low response rates when they were asked to do so. Because of this, the first paper in this chapter, *Delay between recruitment and participation impacts on preinclusion* *attrition* investigates one way in which researchers may retain participants once recruited.

Secondly, once participants are engaged with a study, SMS has limited usefulness as a tool for self-report data collection if it is associated with poor response behaviour. Poor response behaviour includes responses being missing, delayed, or incomplete, and participants dropping out of a study altogether. A fundamental difficulty in comparing the performance of SMS with other data-collection methods is that their differences in performance may be moderated by other factors, such as the nature of the questions or participant characteristics making it impossible to identify and assess all possible moderators of this kind. Instead, this thesis adopts two practical approaches to addressing this problem. One way of examining how study features may impact on response behaviour in SMS research, or interact with the SMS mode itself, is to look for patterns in the extant literature. The second paper in this chapter, *Meta-analysis of response rates when SMS is used as a research mode* does this to provide suggestions regarding how to retain participants, and maximise response rates, when using SMS as a tool for data collection.

The second approach is to design research with an explicitly methodological hypothesis in mind. This provides a clearer picture of the properties of a data collection tool than incidental examination of how that tool fared when the initial research goal was pursuing a substantive hypothesis. The remaining three papers in this chapter take this approach. Perhaps due to the relatively small literature currently using SMS as a tool for self-report research, the meta-analysis revealed two critical knowledge gaps. The first gap is the temporal factors that may influence response rates, including the time of day and frequency of sampling. These are addressed in the third paper in this chapter, *Temporal considerations for self-report research using Short Message Service*. The second knowledge gap concerns how much information can be expected from self-report SMS responses. The fourth paper, *As you Likert – cross-mode equivalence of administering lengthy self-report instruments via text message*, examines how many questions may be asked via SMS before response behaviour and quality break down. The fifth paper, *Short and sweet? Length and informative content of open-ended responses using SMS as a research mode*, examines whether SMS limits the length of answers given via SMS.

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Delay between recruitment and participation impacts on pre-inclusion attrition

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Rapid communication

Delay between recruitment and participation impacts on preinclusion attrition

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Despite being a common aspect of psychological research, the impact of delay between recruitment and active participation on dropout rates has received little research attention. This is probably due to the intuitive sense that longer delays will increase the dropout rate. Preinclusion attrition diminishes sample sizes and may threaten data representativeness. One hundred and two university undergraduates were recruited to participate in a short, one-off study via Short Message Service (SMS). Upon receipt of an SMS indicating consent to participate, the researchers delayed sending the study questions for one day, one week, one month, or two months. Delay was significantly associated with response rate with an 80% response rate in the one-day delay condition, 56% at one week, and 42% at one month. No responses were received in the two-month delay condition. This research confirms that the delay between recruitment and active participation impacts on preinclusion attrition when conducting research via SMS.

Keywords: Research methods; Measurement; Communication; Internet; Cyberpsychology; Longitudinal methodology.

A delay between recruitment and active participation can be an unavoidable artefact of data collection, especially in cases where the researcher has a fixed start time for all participants. This is of particular importance to larger studies, which require more participants and thus need a longer recruitment phase, or research with rare or difficult-to-reach populations. A researcher may choose to delay data collection for pragmatic reasons—it is far easier to keep track of which message has been sent to which participant if they can all be sent on one occasion. A tacitly accepted consequence of this delay is that participants have a tendency to drop out in the period between initial contact and actual participation.

The lack of citations in the preceding paragraph is symptomatic of a dearth of structured research enquiry on this topic in the psychological literature, despite such delays being common in the research process. Whilst some attention has been paid to using reminders after initial contact to improve attendance and response rates in research (e.g., Ashby, Turner, Cross, Mitchell, & Torgerson, 2011; Virtanen, Sirkia, & Jokiranta, 2007), the effect of the duration of the delay has generally only been examined in the context of medical health and clinical psychology interventions. Experimental variation of the delay between initial contact and clinical appointment attendance has demonstrated significantly higher attendance rates associated with shorter delays (Festinger, Lamb, Marlowe, & Kirby, 2002). Where treatment is ongoing, a shorter delay between initial contact

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and treatment initiation is also associated with a greater likelihood of attending subsequent appointments (Hoffman, Ford, Tillotson, Choi, & McCarty, 2011).

The current paper conceptualizes the delay between initial recruitment and participation in a research context as a form of Flick's (1988) preinclusion attrition, where participants do not engage with the researcher any further following initial contact or consent. As in Kendall and Sugarman (1997), participants dropping out at this point in time should not be confused with those who do not consent to participate from the outset, or who notify the researcher of their formal withdrawal. Though it is common practice to report preinclusion attrition defined in this way in psychological research, it is rarely discussed in more detail than a passing count or of dropouts when the sample is described, making it difficult to distinguish between those who drop out before participation and those who drop out during participation. This has resulted in a lack of cumulative evidence to inform reasonable expectations regarding how many participants may be lost. Attrition itself can be a useful outcome variable as it can indicate a methodological flaw or problematic sample (Cook & Campbell, 1979), and it can have effects beyond just diminishing the sample size.

Preinclusion attrition has the potential to create subtle bias in research conclusions. It could result in a nonrepresentatively low number of individuals with characteristics associated with attrition, such as forgetfulness, taking part in the study (Flick, 1988). In experimental designs, if randomization occurs at recruitment, it may imbalance the design in terms of numbers of participants in any given condition. These two problems can compound one another in scenarios where experimental conditions are undertaken at different times, potentially resulting in imbalanced and unrepresentative samples being compared within a study (Flick, 1988). This can be mitigated somewhat by post hoc statistical weighting based upon potentially imbalanced characteristics (e.g., Bloom, 1984), though papers discussing such procedures recommend late random assignment to conditions and urge researchers to minimize the attrition whenever possible (e.g., Benjamin-Bauman, Reiss, & Bailey, 1984).

Whilst it is intuitive that researchers should, wherever possible, minimize the delay between initial contact and recruitment, a more structured investigation on the impact of response delay on preresponse attrition is warranted. One potential confound to such preliminary investigations is perceived response burden, which is closely associated with response rates and attrition (Bolger, Davis, & Rafaeli, 2003). The current research therefore seeks to investigate the influence of a time lag between recruitment and active participation on preinclusion attrition using a methodological framework of minimal burden to participants.

Short Message Service (SMS) is a ubiquitous text-based communication technology that can be used for bidirectional communication with research participants. It has been used as a research mode in personality and social psychology, investigating topics such as happiness (Conner & Reid, 2012) and the dynamics of how couples (Song, Foo, & Uy, 2008) and families (Rönkä, Malinen, Kinnunen, Tolvanen, & Lämsä, 2010) influence one another's moods. It is an ideal test case for the current hypothesis as it is clearly of low burden to participants. It is in common use in the population (75% of Australians send SMS daily; Australian Communications and Media Authority [ACMA], 2011), which means that participants will be comfortable with its use, and the 160-character limit of sending an SMS guarantees a brief research experience. There is also the added benefit that SMS is flexible in terms of the time frame in which participants may be contacted. There is no impetus to begin data collection immediately following recruitment for research using SMS, as once a participant's contact number is obtained it is likely to remain a valid means of contact. The delay between initial contact and active participation is therefore particularly malleable when using SMS as a mode for data collection.

By recruiting participants for minimally burdensome SMS research, and experimentally manipulating the delay between recruitment and participation, this study will investigate the hypothesis that increasing delay between recruitment and participation will be associated with a lower response rate.

EXPERIMENTAL STUDY

Method

Participants and procedure

Undergraduate university students were invited to participate by way of posters with the following information:

> SMS FOR SCIENCE!
>
> Erin, a psychology PhD candidate at the ANU invites you to participate in a study looking at the usefulness of SMS for research. Anyone with a mobile phone is welcome to participate.
>
> Interested? Text "Yes" to XXXXXXX to participate
>
> We will text you two questions about yourself, and one question about using SMS for scientific research. All you need to do is reply to our questionnaire with your answers.

The poster went on to detail ethical considerations, consent and withdrawal—please see the supplemental material. Posters were displayed throughout the Australian National University Campus in popular thoroughfares, such as corridors and dining areas. These areas had variable traffic, but the posters were viewable by several hundred students. Recruitment was undertaken in this way to minimize other effects that may contribute to response rate such as incentives (see Dillman, Smyth, & Christian, 2009; Shih, 2008). Recruitment was undertaken so that all participants would have finished with the study within one academic year. Upon receipt of the "yes" SMS, participants were randomly assigned to a response delay condition of one day, one week, one month (30 days), or two months (60 days) following initial contact. The researcher did not contact the participants in any other way (i.e., to confirm receipt of the "yes") in the interim and subsequently communicated only by SMS. A three-item questionnaire was sent to all participants via SMS at 2:00 pm on their assigned day, asking for a prompt response via SMS. Analysed as part of a separate study, the SMS questionnaire asked participants for their age, gender, and (depending on random assignment to two counterbalanced wording conditions) whether they felt there was information they would feel comfortable disclosing via SMS but not via other modes, or via other modes but not SMS.

A total of 102 participants contacted the researcher and were assigned to delay conditions (one day $n = 27$, one week $n = 27$, one month $n = 24$, and two months $n = 24$). Those who responded to the subsequent questionnaire were aged between 17 and 46 years ($M = 24$, $SD = 7$); 73 were female.

Results

Descriptively, the response rate diminished considerably with increasing preinclusion delays, at 80% following one day delay, 56% at one week, 42% at one month, and complete nonresponse at two months (Figure 1).

Logistic regression (with the 60-day delay condition excluded from analysis as it destabilized the model) confirmed that this effect was significant. According to McFadden's published cut-offs (McFadden, 1974), the overall model had a reasonable McFadden's pseudo R^2 (.15) and indicated that participants experiencing a one-week preinclusion delay ($b = 1.26$, Wald $z = 2$, $p = .04$) or a one-month delay ($b = 1.81$, Wald $z = 2.82$, $p = .004$) were significantly less likely to respond than those experiencing a single-day delay. Specifically, those in the one-week delay condition were 3.5 times less likely to respond, and those in the month delay condition were 6 times less likely to respond. Follow-up Wald tests indicated that the drop in response rate between one-week and one-month delays was also significant, $\chi^2(2) = 8.1$, $p = .018$.

Discussion

The delay between recruitment and active participation in the brief SMS questionnaire significantly affected preinclusion attrition. Similar to the

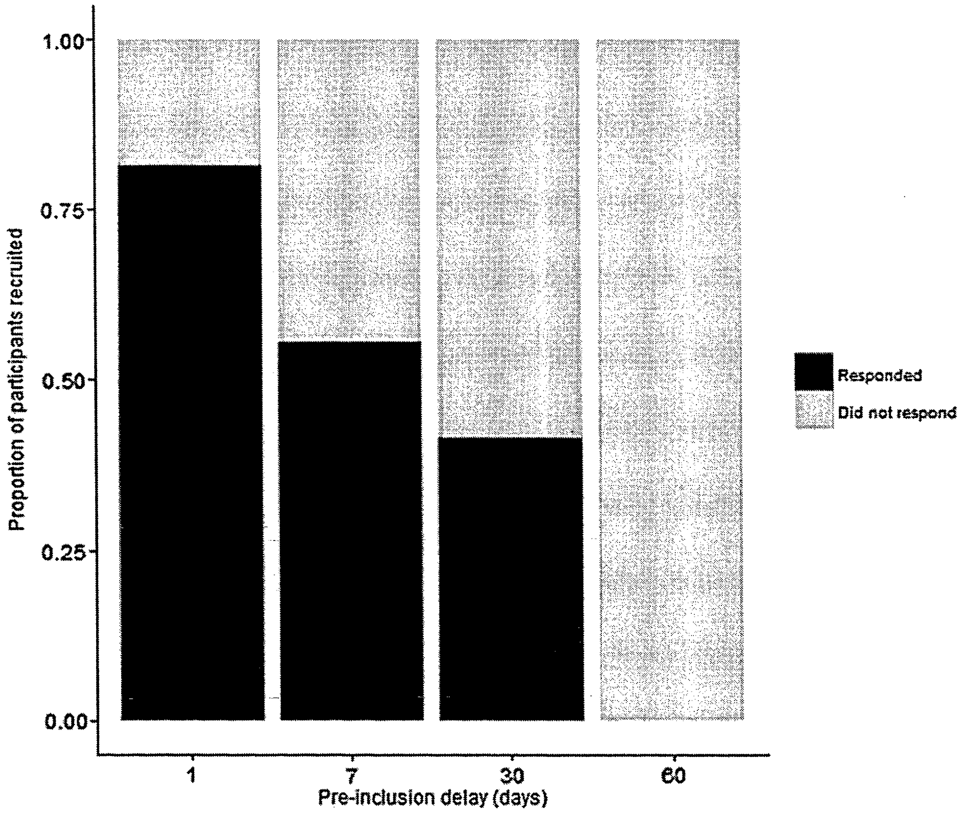

Figure 1. *Response rates across the preinclusion delay conditions.*

clinical appointment attendance literature (Festinger et al., 2002; Hoffman et al., 2011), increasing delays were associated with significantly lower response rates, both statistically and practically. It suggests that, at least when using SMS as a research mode, delaying active participation even for a week can drastically increase preinclusion attrition. This brings with it problems of reduced sample size, such as diminished statistical power, and increased likelihood of nonrandom dropout, which can threaten the representativeness of an originally carefully chosen sample (Flick, 1988). This suggests that avoidable delays, such as delaying to allow a fixed schedule for the researcher's convenience, are inadvisable.

Due to the formative nature of this research, the time frames of delay were somewhat arbitrary and widely spaced. In particular, the remarkable decline in responses between 30 and 60 days bears closer scrutiny, perhaps with finer differences in delay manipulations (i.e., 30 days versus 35 days, etc.). Doing so would help to build a more detailed understanding of potentially useful delay cut-offs to guide planning of research using SMS as a data collection tool in situations where all data must be collected at the same time. For example, a researcher seeking to collect opinion data surrounding a national election would find it useful to know whether they may begin contacting and recruiting participants a month before the election (thus maximizing the time they have to recruit as many people as possible), or whether they should wait longer (in order to minimize preinclusion attrition).

The current study used only university students. Given that different ages engage with technologies like SMS in different ways (Venkatesh, Thong, &

Xu, 2012), these findings may differ with an older sample. It is possible that the middle-aged and elderly, due to their comparatively lower use of SMS, may have a higher preinclusion attrition rate than the current sample. Specific groups, such as clinical populations, may also differ in their SMS engagement in a way that impacts upon preinclusion attrition. One source of difference may be intervening life events that may distract or impair a participant's ability to respond, such as an extended holiday, or moving house. In the university student sample, teaching breaks and graduation are such events. Though the current study avoided delays over a new-year period, those in the longer delay conditions experienced a midsemester teaching break. This may have further distracted them from finally participating and provided greater scope for mobile telephone loss, or number changes, which could have rendered them unavailable for eventual responding. Delay is one of many factors that may impact on preinclusion attrition. In online and paper surveys, there is evidence that response rates in single measure surveys and ongoing participation in repeated measures frameworks are modifiable by researcher initiatives such as incentives (Dillman et al., 2009; Shih, 2008) and prenotification or reminders before participation (Cook, Heath, & Thompson, 2000). A further factor may be the anticipated burden of the research, modifiable by the number, length, and scope of questions to be asked (Bolger et al., 2003). Though this research focused on other modes, it is quite possible that the provision of an incentive, or use of reminders, would improve response rates at longer delays in research using SMS as a data collection method, The current study's minimal contact between researcher and participant may serve to provide baseline expectations for the impact of delay on participation, allowing future researchers a framework to guide investigations of the effects of incentives, prenotifications, reminders, and other methods commonly used to increase response rates in self-report research.

This study experimentally manipulated the delay between recruitment and participation in self-report research undertaken via SMS. As hypothesized, longer delays between recruitment and participation were associated with a lower response rate. The response rate at a one-day delay was almost double that at a one-month delay. There was complete dropout at a two-month delay. Pragmatically, these results suggest that a researcher should avoid delaying active participation when collecting data via SMS without a strong theoretical rationale for doing so.

Supplemental material

Supplemental material is available via the "Supplemental" tab on the article's online page (http://dx.doi.org/10.1080/17470218.2015.1008019).

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Response rates where SMS is used as a tool for self-report psychological research, a meta-analysis

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Short Message Service (SMS) is a ubiquitous text-based communication tool with potential applications for collecting self-report research data. This meta-analysis draws from the existing literature to explore whether particular study features are associated with response rates when using SMS as a tool for self-report data collection. SMS-related keywords were used to search six major journal databases. Of the original sample of 1049 papers, 122 studies met the inclusion criterion of participants sending self-report data to researchers via SMS. Response rates averaged 53% across studies. Studies where the research topic was salient to participants, and participants reflected upon themselves (rather than other-report, or facts) had significantly higher response rates. Incentives and follow-up messages for missed responses were associated with significantly higher response rates. Follow-up reminders were particularly effective for child samples, while incentives were more effective for adult samples. SMS provides acceptable response rates when used as a tool for self-report data collection.

The ubiquity and constant use of Short Message Service (SMS) in daily lives (Anhoj & Moldrup, 2009; Mackay & Weidlich, 2009) heralds a unique opportunity for communication between psychology researchers and their participants (Haller, Sanci, Sawyer, Coffey, & Patton, 2006). SMS is gaining traction as a tool for self-report psychological research (Conner & Reid, 2012), but is still a relative newcomer to the psychology researcher's methodological toolkit. It is an opportune time to reflect on how SMS has been used thus far, and how it may best be used in future. The importance of scrutinising the methodological aspects of past research to inform future research design is emphasised by the large literature examining data collection modes such as paper, online, and even mixed-mode surveys (e.g. Beardsley, Wish, Fitzelle, O'Grady, & Arria, 2003; Dillman, Smyth, & Christian, 2009; Edwards et al., 2009; Khosropour, Lake, & Sullivan, 2014; Sheehan, 2006). To date, there is a paucity of research specifically investigating the properties of SMS as a tool for self-report data collection. One pertinent issue is how SMS may perform in terms of response rates.

Aiming for a high response rate increases sample size, and reduces the issue of non-response bias (Fox, Crask, & Kim, 1988; Shih, 2008). Even if sampling begins as representative, non-responses can result in imbalanced representation of a given population if respondents differ systematically from non-respondents (Flick, 1988; Groves & Peytcheva, 2008). Maximising response rates through design choices avoids post-hoc statistical adjustment, allowing conclusions to be drawn more directly from the actual data rather than more indirect estimations of the data. Despite attempts to improve design, response rates in the health and psychology literature are often quite low.

In meta-analyses pooled across topics, methodologies, and fields, response rates in self-report research are estimated at averaging between 47% and 50% (Baruch & Holtom, 2008; Baruch, 1999; Yu & Cooper, 1983). Online surveys are currently the most common self-report methodology in psychology and health research and often produce response rates less than 40% (Cook, Heath, & Thompson, 2000; Shih, 2008). Cook et al. (2000) note that meta-analyses are likely to overestimate response rates, as studies with particularly low response rates are unlikely to be published suggesting that true response rates may be even lower. Poor response rates are not inevitable, with methodologists such as Dillman et al. (2009) arguing that they can be meaningfully improved with careful research design.

An important design consideration associated with response rates is the mode with which data is collected (Cook et al., 2000; Shih, 2008; Tsai et al., 2007). Like the internet, SMS is a technology already integrated into people's everyday lives but unlike the internet, SMS usage tends to focus more on bi-directional communication than passive receipt of information. This pre-existing ubiquity, and conversational usage in everyday life, may result in SMS yielding higher response rates. Conversely, response burden due to SMS being bound to a small mobile telephone screen, and the brevity of the character limit, may result in low response rates. Because the larger framework of study design, such as the target sample and research topic, is associated with both appropriateness of a mode (Dillman et al., 2009) and response rates (Heberlein & Baumgartner, 1978), SMS response rates may be contingent on particular features of a research project. These features include the contact the researcher has with participants, incentives for participation, the salience and sensitivity of the research topic, the presence of other modes, the duration of data collection, and the population being sampled.

Just as investigation of previous paper, online, and mixed-mode data collection has provided valuable guidance for ongoing research design, this meta-analysis will quantify what response rates may be expected when using SMS as a tool for self-report data collection, and whether particular study features are associated with response rates. The aim is to draw on the small but growing literature where SMS has been used to guide expectations and highlight specific design considerations pertinent to psychology researchers considering using SMS as a tool for self-report data collection.

Method

Sample

Combinations of the key words *SMS, text, message, txt, mobile,* and *telephone* were entered into six databases (ScienceDirect, Ovid, PubMed, ProQuest, PsycInfo, and Google Scholar). Books, dissertations and conference proceedings were included alongside peer-reviewed journals to avoid a possible publication bias against research with low response rates (Heinsman & Shadish, 1979). An initial pool of 1049 papers published prior to April 2014 was identified.

Criterion for study inclusion

To be included, studies must involve participants sending information to the researcher via SMS, either as a sole response mode, or in the context of a mixed-mode study. Papers which used SMS to collect data but did not report response rates were also discarded. Some papers included multiple constituent studies; the unit of discussion in the current paper is studies rather than papers. This resulted in a final sample of 122 studies.

Coding of study features

Studies where SMS was used as a response mode were coded according to a pool of properties drawn from the literature, with the addition of some additional categories specific to SMS. Different factors were grouped under seven headings, see table 1 for an overview.

Contact. Research regarding online surveys has demonstrated that communication with the researcher outside of data collection can improve response rates (Cook et al., 2000; Shih, 2008). Studies using SMS as a data collection mode were coded according to whether there was 1) pre-notification that data collection was soon to commence (additional to the initial recruitment procedure), 2) personalised contacts (i.e. messages including participant names), 3) a reminder was sent if an initial response was not provided, and 4) a physical meeting with the researcher or their assistants at any point (as opposed to purely online, telephone, or email participation).

Incentive. Incentive is anything that participants received in return for participation and was coded as no incentive, monetary or alternative incentive (e.g. course credit). When participation may incur a cost, reimbursing participants can improve response rates (Heberlein & Baumgartner, 1978). Because sending SMS may cost the participant, studies were also coded for whether participants were reimbursed, or were provided with a mobile device for the purposes of participation.

Table 1. *Percentages of studies where SMS is used as a data collection mode with a particular feature*

	%		%
Contact		Context	
Pre-notification †*	7	Other modes (choice) ►	2
Contact personalisation †	2	Other modes (complimentary) ►	22
Follow-up reminder ►	21		
Physically met the researcher	13	Course	
Incentive		Single measure	20
No incentive ►	78	Repeated measures (same items)	50
Monetary incentive †	10	Repeated measures (different items)	6
Credit incentive †	1	Sampling rate	
Gift incentive	9	Once	20
Participation costs √	11	Daily	49
Device provided	5	Weekly	22
Topic		Monthly	3
Sensitive topic †	40	Schedual	
Salient topic †	63	Fixed	49
Behavioural *	49	Random	4
Experiential/attitudinal *	39	Sample	
Other	9	University undergraduates †	7
About self	85	School children √	2
About others √	6	Professionals ►	9
Facts	5	Employees √►	6
		Children †	14
		Specific population	56
		General population †*√►	1

Note. These figures are taken from the full *n*=122 studies that had this property, including those which did not report a response rate. As few studies reported all properties, *n* will differ on a per-analysis basis. % is the percentage of studies that had this property. † properties drawn from Cook et al., (2000); * in Groves and Peytcheva (2008); √ in Heberlein and Baumgartner (1978); and ▸ in Shih (2008).

Topic. The topic of the research may impact on response rates. Studies were coded according to salience, sensitivity, and whether the topic was behavioural, experiential or factual. Simplifying Cook et al. (2000)'s modification of Heberlein and Baumgartner (1978)'s approach by coding in a binary yes/no fashion, the current analysis considered a study salient if it "dealt with important behaviour or interests that were also current", for example, an instrument about exam stress administered to university students during an examinations period (Heberlein & Baumgartner, 1978; p.449). A study was coded as sensitive if it met the criterion proposed in Lee and Renzetti, (1990). A topic is sensitive if it intrudes into the participant's privacy or particularly personal experience, impinges on the vested interests of someone in a position of power over the participant, or deals with anything sacred to the participant. Salience and sensitivity were coded by two independent researchers. The topic was behavioural if it related to behaviour (e.g. "Did you exercise today?"), experiential if it related to thoughts or feelings (e.g. "How do you feel right now?") or factual if it relates to facts (e.g. "How many minutes in an hour?"). A final distinction was whether the data collection was largely about the self (e.g. "Do you drive a blue car?"), rather than factual information (e.g. "How many blue cars are there?") or others (e.g. "Does your spouse drive a blue car?").

Context. These are the factors surrounding the use of SMS. As the participation experience can differ in mixed-mode research compared to data collection via a single mode (Dillman et al., 2009), studies were coded according to whether participants chose to use SMS from other available modes, were assigned to use SMS, or used other modes of response as well as SMS. Another contextual issue relates to the time burden of completing the survey, that is how many questions participants are asked on each response occasion. This is important as response burden is closely associated with response rates and attrition (Bolger, Davis, & Rafaeli, 2003). This was coded as a numeric count of questions per sampling occasion.

Course. This refers to whether the research used SMS as a single measure (i.e. a single follow-up question), repeated measures with the same items each time (as would be the case in mood tracking) or repeated measures with different items each time (as would be the case for a multi-wave or flexible experiential sampling study).

Sampling rate. Related to course, this is how often participants were asked to respond; once, daily (or multiple times within a day), weekly (or multiple times within a week, yet not daily), or monthly.

Schedule. When conducting repeated measures research, data may be collected on a fixed schedule (i.e. 7:00am and 7:00pm daily), or on a random schedule (i.e. at two points between 7:00am and 7:00pm, the timing differing each day). Fixed schedules are beneficial in that SMS responses can be integrated into participant's everyday routine (perhaps fostering higher response rates), but can beget response anticipation biases. Both fixed and random sampling schedules are common in the ambulatory assessment literature (Bolger et al., 2003).

Sample. This refers primarily to how participants were sourced. Professionals are those recruited on the basis of their occupation but not organisation (i.e. a sample of lawyers), whilst employees are those recruited on their basis of belonging to a given organisation (i.e. a sample of Microsoft employees, who may have differing roles within the company). University undergraduates are a common participant pool. The sample is considered school children if recruitment took place in a school setting (such as during classroom exercise), and children if recruitment took place some other way (such as recruiting through parents by way of a newspaper advertisement). Specific populations are those recruited on the basis of a personal characteristic or membership to a group not outlined previously (such as deaf individuals, or members of an ethnic community). A general population sample may include the above groups, but is distinguished in that the researcher was not specifically targeting any of those groups.

Note that age is treated here as a categorical distinction between 'adult' and 'child'. Though there are widely documented disparities in mobile phone ownership, and usage, across age groups, age-based differences in mobile ownership and SMS usage among adults are becoming less pronounced as mobile telephone uptake continues (Ling, 2010). Children (defined here as those aged 15 or younger) engage with mobile telephones in a qualitatively different way from adults (Lorente, 2002). Further, research with children is markedly different from research with adults due to issues of guardian consent, attention span, and topic sensitivities (Inyang et al., 2010). Therefore, age is considered in the current analysis only in terms of child (15 or younger) or adult participants.

Analysis plan

As in Heberlein and Baumgartner (1978), where most meta-analyses concern themselves with the effect size of the relationship beween an independent and dependent variable, here the 'effect size' of interest is the response rate. This is operationalised in a binomial logistic regression, with counts of response (or non-response) as the binary outcome variable. In this way, the analysis finds the probability of obtaining a response given any particular set of study properties (P), which is given by:

$$P = \frac{e^{m+\beta x}}{1 + e^{m+\beta x}}$$

Where e is the natural logarithm, m is the intercept, x is the slope, and β is the magnitude of the increase in the probability that response was given for each unit increase in x. P ranges from 0 (certainly no response will be received) to 1 (a response will certainly be received). The exponent of P can be taken to give the odds ratio, which can be interpreted as the ratio of the odds of an event occurring versus it not occurring. These odds ratios should be interpreted in the context of τ, which is indicative of the rareness of the 'event'. τ is calculated here as the proportion of total possible responses that were in the presence of the study property, essentially pooling across studies:

$$\tau = \frac{\sum \text{participants x measurement occasions where property is present}}{\sum \text{participants x measurement occasions across all studies}}$$

Weighting. Here, the outcome variable is specified in terms of $n^{\text{responses}}$ and $n^{\text{non-responses}}$ pooled across responses, participants, and studies. This intrinsically weights response rates by sample size, as larger studies will have a greater number of responses and non-responses in total than smaller studies. For descriptive statistics and continuous analyses, here, as in Cook et al. (2000), the response rate was quantified as the number of responses divided by the sum of responses and non-responses in each study. This operationalization on a study-by-study basis requires weighting as in Shih (2008) to minimise potential bias caused by instability due to small sample sizes. Reported descriptive statistics are weighted on this basis.

Over-dispersion

It is likely that some study properties will be relatively uncommon. It is also likely that sample sizes will be bimodal, with small experimental studies under $n<250$, and larger population studies with n in the tens of thousands. This is likely to cause poor model fit due to over-dispersion, measured here by the dispersion parameter φ:

$$\varphi = \frac{\text{model residuals}^2}{\text{model residual degrees of freedom}}$$

In binomial logistic regression with relatively large sample, φ is expected to approach 1. In analyses where this is not the case, we will proceed using logistic regression on the full sample, on a truncated sample (where $n<250$), and rare event logistic regression as implemented in R by Kosuke, King & Lau (2014). Rare events logistic regression coefficients will be prefaced by 'REL' in text. Weighted and unweighted descriptive statistics will both be reported to give context to the reader, with weighted descriptive prefaced by a 'W'. Statistical significance will only be inferred where different modelling techniques generally lead to the same conclusion, the most appropriate modelling technique converges, has reasonable residual error, and makes sense given the weighted descriptive statistics. Where these criterion are not met, the model will be considered unstable, and only descriptive statistics will be reported.

Results

Research using SMS is methodologically heterogeneous in terms of the sample, topic, and the way in which SMS is used. See table 1 for a summary, and Appendix 3 for a full list of studies and their features. In the following results, rarity of some study features will be noted. Descriptive results and analyses are only reported where study features were common enough to allow model convergence.

Response rates ranged from 1% to 100%, averaging 53%. Most studies using SMS as a data collection mode had moderate sample sizes (n<100), with a few notable outliers of extremely large studies (n>250). Inspection of the funnel plot (Figure 1) shows a general trend toward lower response rates with increasing sample sizes. Indeed, logistic regression confirms that there is a small but significant negative relationship between sample size and response rate (b=-0.002, SE<.001, p<.001); as samples get larger, the response rate becomes lower.

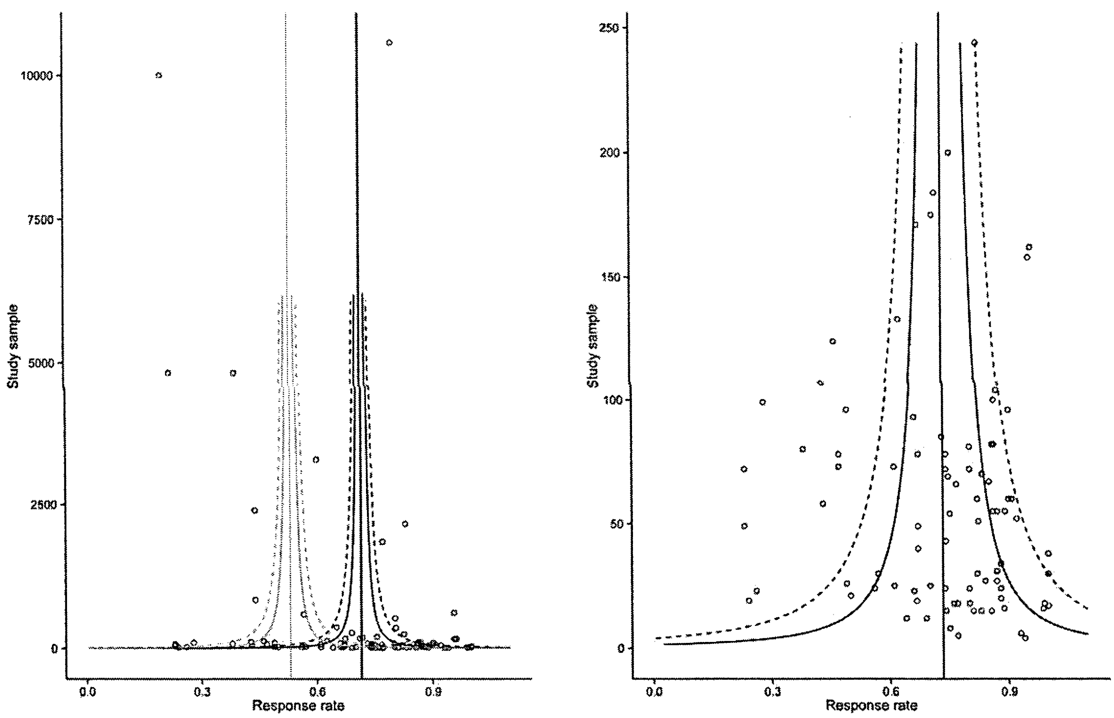

Figure 1. Funnel plot of response rate by study sample size.

Note. The left shows the full range of study sample size with funnels for both weighted (grey) and unweighted (black) means. The right panel shows truncated range of study sample size, with unweighted means. The solid line indicates mean response rate. The solid curve indicates 95% SE level, the dashed curve 99%.

Contact. Most studies did not involve contact between the researcher and participant outside of data collection (Table 1), with very few studies using physical meetings with the researcher and contact personalisation. There was a small but significant negative association between pre-notification and response rate, with a 58% response rate in those pre-notified versus 64% in those not pre-notified, (φ=566, τ =.04; REL b=-0.267, SE=0.02, p<.001; OR=.766). The most common and effective contact with participants was sending a follow-up reminder when expected responses were not received. Doing so was associated with significantly higher response rates (φ=556, τ=.07, REL b=0.59, SE=0.02, p<.001; OR=1.8), with a 66% response rate where follow-up reminders were sent, versus 52% response rate where they were not.

Incentive. The majority of studies did not offer participants an incentive in return for their participation, with notably very few reporting a research credit incentive (resulting in too few to analyse). The majority offered either monetary or gift type incentives, rarely both. Doing so significantly improved response rates, with an average 72% response rate in studies offering either incentive as opposed to a 52% response rate in those that did not (monetary φ=563, τ =0.11; REL b=0.30, SE<.001, p<.001; OR=1.355; gift φ=522, τ =.09; REL b=.423, SE=.013, p<.001; OR=1.5). Very few studies reimbursed participants for the cost of SMS sent during data collection, but those which did had a significantly higher response rate, averaging 69%, as opposed to 53% (φ=512, τ =.16; REL b=.79, SE=0.01, p<.001; OR=2.22). Only five studies provided a mobile device or SIM card.

Topic. Following Landis and Koch (1977)'s criterion cutoffs for inter-rater agreement statistic kappa, researchers were in substantial agreement for coding salience (k=0.69, 95% CI [0.48, 0.9]), and moderate agreement for coding sensitivity (k=0.42, 95% CI [0.42, 0.57]). The following discussion is based on the primary investigator's coding. All studies regarding sensitive topics were also considered salient though not all salient topics were sensitive. Salience was significantly associated with a higher response rate, with an average 55% response rate where the topic was salient, and 52% where it was not (b=.93, SE=0.009, p<.001; OR=2.54). The vast majority (85%) of the studies collected data about the self rather than factual information or others. Response rates were comparable (≈73%) for where the focus was the self or facts, but was significantly lower (57%) where the focus was other people (φ=564, τ =.01; REL b=-0.7961, SE=.037, p<.001; OR=0.451).

Context. Studies had participants respond on between 1 and 840 occasions (median of 14 occasions), asking between one and 24 questions (M=4) on each occasion. Neither number of sampling occasions nor number of questions was significantly associated with response rate. Only 22% of studies using SMS as a mode of data collection did so in a multi-modal setting. Where it was used as a method of data collection, other modes of data collection used alongside SMS included online, email, paper, and smartphones. Models of the association between the presence of other modes and sample size or response rate were unstable.

Course. SMS was used for both one-off large scale studies, and smaller ongoing repeated measures sampling. Sampling once was associated with significantly lower response rates (66%) than sampling repeatedly (73%; b=-.197, SE=0.01, p<.001; *OR*: 0.302). Almost all of the studies using SMS for repeated measures sampling used the same questions repeatedly, rather than asking different questions on each occasion.

Sampling rate. Repeated sampling, whether daily (b =1.26, SE=0.11,p<.001; OR=3.53), weekly (b=.966, SE=0.1, p<.001; OR=2.62) or monthly (b=.302, SE=0.31, p<.001; OR=1.35) had significantly higher response rates than sampling only once. Most studies with repeated measures sampled on a daily or weekly basis. With an average 74% response rate, studies sampling weekly did not have a significantly higher response rate than those sampling daily, which had an average response rate of 72%.

Schedule. The overwhelming majority of studies which specified their sampling schedule (90%) employed a fixed, rather than random or flexible schedule. There were too few studies with non-fixed schedules to statistically compare response rates among fixed versus random schedule studies.

Sample. The studies reviewed included participants of between 8 and 58 years (M=29). The overall gender balance across studies was relatively equal, at 63% female. Over half (55%) of the samples used were selected on the basis of belonging to a specific population, typically sufferers of a physical or mental illness. Collapsing sample sub-categories into adult (n=94) and child (n=10) shows that response rates are significantly higher for adults (70%) than for children (44%; φ=610, τ =.99; REL b=-1,058, SE=3.5, p<.001; OR=0.34).

Effective strategies for maximising response rates. A series of logistic regressions were used to explore whether particular combinations of study features were associated with higher response rates (coefficients displayed in table 2). Due to the small and unbalanced numbers of studies including the factors needed for comparison, and notably small power, these models should only be interpreted in terms of relationship directionality (rather than magnitude). These patterns of significant interactions, as summarised in Figure 2, show a suggested decision process for optimal strategies to improve response rates.

Table 2. *Logistic regressions for effective strategies at maximising response rates.*

	b	OR	SE	Z	*p*	R2
Model 1: Course x Incentive						0.29
(Intercept)	-0.09	0.91	0.01	-8.84	<0.01	
Repeated (as opposed to single occasion)	1.32	3.74	0.01	109.54	<0.01	
Incentive (yes, as opposes to no)	0.93	2.53	0.03	30.28	<0.01	
Repeated x incentive	-0.99	0.37	0.03	-28.64	<0.01	
Model 2: Salience x Follow up reminders						0.21
(Intercept)	0.27	1.31	0.01	35.31	<0.01	
Salient (as opposed to not salient)	0.94	2.55	0.01	97.91	<0.01	
Follow up reminder (as opposed to none)	0.80	2.23	0.04	19.38	<0.01	
Salient x reminder	-0.44	0.65	0.05	-9.31	<0.01	
Model 3: Salience x incentive						0.34
(Intercept)	-0.15	0.86	0.01	-15.76	<0.01	
Salient (as opposed to not salient)	1.36	3.89	0.01	122.45	<0.01	
Incentive (as opposes to no incentive)	1.32	3.72	0.02	77.34	<0.01	
Salient x incentive	-1.13	0.32	0.02	-47.41	<0.01	
Model 4: Focus x follow-up reminder						0.03
(Intercept)	0.877	2.40	0.014	64.261	<0.01	
Focus (self, rather than others or facts)	0.015	1.02	0.014	1.042	0.297	
Follow up reminder (as opposed to none)	-1.116	0.33	0.071	-15.761	<0.01	
Focus (self) x follow-up	1.823	6.19	0.074	24.727	<0.01	
Model 5: Focus x facts						0.03
(Intercept)	0.837	2.31	0.015	55.812	<0.01	
Focus (self, rather than others or facts)	0.012	1.01	0.016	0.762	0.446	
Incentive (as opposes to no incentive)	0.002	1.00	0.033	0.075	0.94	
Focus (self) x incentive	0.48	1.62	0.035	13.724	<0.01	
Model 6: Age group x follow-up reminder						0.08
(Intercept)	0.99	2.70	0.01	186.70	<0.01	
Age group (child, as opposed to adult)	-0.90	0.41	0.02	-55.58	<0.01	
Follow-up reminder	0.31	1.37	0.02	14.21	<0.01	
Age group (child) x follow-up	1.48	4.38	0.05	30.61	<0.01	
Model 7: Age group x incentive						0.09
(Intercept)	0.88	2.42	0.01	153.39	<0.01	
Age group (child, as opposed to adult)	-0.31	0.73	0.02	-18.95	<0.01	
Incentive (as opposes to no incentive)	0.61	1.84	0.01	45.89	<0.01	
Age group (child) x incentive	-1.30	0.27	0.04	-35.64	<0.01	

Note. Base group for comparison displayed with all coefficients. R^2 displayed is McFadden's pseudo R^2, calculated using the pscl package in R.

Incentives were associated with higher response rates when sampling on a single occasion, rather than repeated sampling. Follow-up reminders and incentives interacted significantly with salience, and were particularly associated with higher response rates when the topic was not salient. They also significantly interacted with focus, and were particularly associated with higher response rates when the focus was on the self. Follow up reminders were associated with higher response rates in children than adults, whilst incentives were associated with higher response rates in adults. This last interaction should be interpreted with caution due to the very small number of child participants offered an incentive (a single study with 78 participants responding across 56 sampling occasions).

Discussion

This meta-analysis showed that there is a wide variety of ways in which research which has used SMS as a tool for self-report data collection, with the most common being repeated measures sampling, on a fixed schedual, with the same questions asked at each sampling occasion. This likely reflects the flexibility of SMS as a convenient, comparatively unobtrusive tool for experience sampling methods (Conner & Reid, 2012; Haller et al., 2006). By examining how the methodological features of these studies are associated with response rates, we have uncovered some useful information for guiding future application of SMS in a research setting. Overall, response rates compared favourably to those in the broader psychology literature (e.g. Baruch & Holtom, 2008; Baruch, 1999; Cook et al., 2000; Yu & Cooper, 1983).

Similar to the literature for other research modes, studies with salient topics, and repeated rather than single-occasion sampling, also had higher response rates (Cook et al., 2000; Heberlein & Baumgartner, 1978; Shih, 2008). Studies employing strategies such as incentives, reimbursement, and follow-up for missed responses had higher response rates(Cook et al., 2000; Heberlein & Baumgartner, 1978). In comparison to slow-paced data collection modes such as postal surveys, follow-up reminders are particularly feasible to implement in SMS research, as many online SMS services allow programmed monitoring of incoming responses, and automatic follow-up scheduling if a missing response is detected. It is notable that these results indicated that the efficacy of follow-up messages and incentives may depend somewhat on other, less mutable, study properties, notably whether the target sample were adults or children.

The literature for online surveys suggests that pre-notifications should be associated with higher response rates (Cook et al., 2000), but here, studies using pre-notification had lower response rates. This may be because researchers only used pre-notification when they anticipated that a particular sample would yield low response rates, hence a positive effect of pre-notification on response rates would be masked. This possibility could be clarified in future research by random assignment of participants into pre-notification and non-pre-notification conditions in research using SMS as a tool for data collection. One potential mechanism by which pre-notification could have a detrimental effect on response rates in SMS data collection, where it has a positive effect in other modes, is through desensitisation – a participant may be less likely to check and respond to the actual survey message, because they have already received a pre-notification message that required no response.

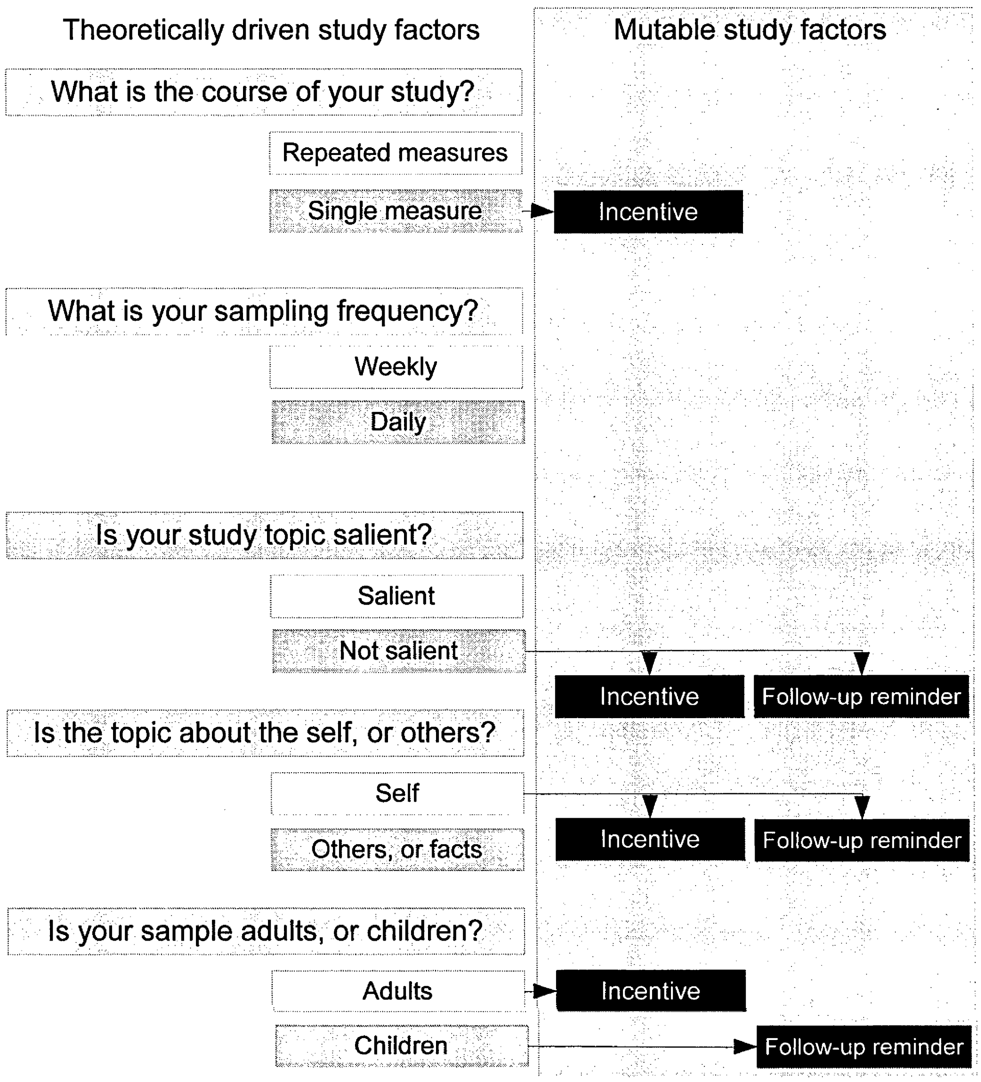

Figure 2. Patterns of response rate improvements.

Note. Dark grey boxes indicate significantly poorer response rates than white boxes. Incentives and follow-up reminders are associated with significantly higher response rates across all study factors. Arrows and black boxes indicate particular efficacy (i.e. an incentive is effective in increasing response rates for both child and adult samples, but it is more effective for adult than child samples).

There is a strong possibility that publication bias may have impacted upon these results, inflating the apparent response rate in research using SMS to collect data. Response rate dictates the amount of data available for analyses. Smaller studies are more vulnerable to low statistical power due to missing data than larger studies - a 50% non-response rate is disastrous for statistical power in a sample of fifty, but not a sample of five hundred. This could well lead to an under-representation of smaller studies with low response rates, which may in turn obscure the properties of unsuccessful research with smaller sample sizes.

The ubiquity of SMS usage in everyday life has created a new methodological opportunity for psychological and health researchers (Anhoj & Moldrup, 2009; Haller et al., 2006; Mackay & Weidlich, 2009). Because high response rates maximise sample size and minimise non-response bias (Fox et al., 1988; Groves & Peytcheva, 2008; Shih, 2008), a key issue when exploring SMS as a self-report research methodology is response rate. This meta-analysis explored a number of factors that have impacted on response rates in other modes. Despite some study features being too rare for statistical analysis, several features were significantly associated with response rates. Taken together, results suggest that a researcher collecting data via SMS wishing to maximise their response rate should choose a salient research topic where respondents reflect upon themselves rather than someone else, use follow-up messages to prompt missed responses, and provide an incentive for participation.

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For references contained within the meta-analysis, see Appendix 3.

Temporal considerations for self-report research using Short Message Service

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Research Report

Temporal Considerations for Self-Report Research Using Short Message Service

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Abstract. When using Short Message Service (SMS) as a tool for data collection in psychological research, participants can be contacted at any time. This study examined how sampling frequency and time of day of contact impacted on response rates, response completeness, and response delay in repeated measures data collected via SMS. Eighty-five undergraduate students completed a six-item self-report questionnaire via SMS, in response to 20 SMS prompts sent on a random schedule. One group responded across 2 days, the other on a compressed schedule of 1 day. Overall, there was a high response rate. There was no significant difference in response rate, completeness, and delay of those responding across 1 or 2 days. Timing between prompts did not impact on response behavior. Responses were more likely to be complete if prompts were sent during the working day. The shortest time between prompts was 15 min, however, and use of an undergraduate sample limits generalizability. When conducting repeated measures sampling using SMS, researchers should be aware that more frequent sampling can be associated with poorer data quality, and should aim to collect data during the working day rather than mornings or evenings.

Keywords: methodology, data quality, Short Message Service, mobile telephone

There is almost total saturation of mobile telephone ownership in Australian adults (Australian Communications and Media Authority, 2013) and high levels of mobile ownership globally (Anhoj & Moldrup, 2004). This offers access to research participants regardless of their location (Haller, Sanci, Sawyer, Coffey, & Patton, 2006). Short Message Service (SMS) is a text-only communication method available on almost all mobile telephones. Although the rise of smartphones has led to considerable uptake of other mobile text-based communication technologies, SMS is used by many people daily and is likely to remain relevant in the future (Australian Communications and Media Authority, 2013; Deloitte Touche Tohmatsu Limited, 2014; Mackay & Weidlich, 2009). SMS is particularly suited for repeated measures research due to its preexisting integration into participants' everyday lives and low cost. Its bidirectional nature lends itself to signal-contingent sampling, where participants provide answers when prompted, rather than when an event occurs or on a response schedule without reminders to respond. Though there is a growing body of psychological research using SMS in repeated measures data collection, there is still a dearth of systematic methodological examination of its properties as a research mode (Cocco & Tuzzi, 2012; Tomlinson et al., 2009). One area to be investigated is the temporal properties of SMS as a tool for data collection – specifically, how the timing of sampling (both frequency and time of day) may impact on response behavior.

Sampling frequency can be thought of as the number of responses required over a fixed period of time (such as a day), or the amount of time that has passed since the last response was required, defined here as *prompt spacing.* Thinking of sampling frequency in terms of prompt spacing is particularly helpful if responses are sought on a random schedule, which is often done to avoid behaviors being altered by the expectation that a response will soon be required (Wheeler & Reis, 1991). The use of a particular sampling frequency is broadly driven by the expected change, variability, or frequency of what is being measured. For example, a mood-tracking questionnaire may be appropriate for shorter intervals (Cranford et al, 2006), but a voting habits questionnaire would be more appropriate over longer periods (i.e., yearly, as in Wright, 1993). When judging an appropriate sampling frequency, particularly when change can be expected to be rapid (e.g., mood), researchers face some decisions: More frequent sampling minimizes recall bias and increases study power (Raphael, 1987; Raudenbush & Xiao-Feng, 2001); however, increased frequency places a greater burden on participants (Bolger, Davis, & Rafaeli, 2003), which may reduce compliance and produce poorer quality data (Ebner-Priemer & Kubiak, 2007).

Using SMS for repeated measures self-report data collection has occurred across a wide range of sampling frequencies, from eight times daily for 21 days (Berkman, Dickenson, Falk, & Lieberman, 2011) to monthly over

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the course of a year (Shrewsbury et al., 2010). Ebner-Priemer and Kubiak (2007) note the lack of structured investigation of methodological aspects of repeated sampling designs and limited justification for sampling frequency in the wider repeated measures literature, a criticism that applies to the mode of SMS. There is one example where sampling frequency of SMS was systematically manipulated (Conner & Reid, 2012); however, this was focused on the implications of oversampling on the construct being measured, rather than the impact on response behavior itself. Such research addresses the inevitable interactions between research topics, question types, sampling frequencies, and resultant response behavior, but more methodologically focused investigations are required to form basic foundations for expected response behavior.

One aspect of data quality is response behavior. This is how participants engage with research in terms of response rates, response completeness, and response delay. Response rates can be impacted by many factors, such as poor study design or a difficult-to-reach sample (Dillman, Smyth, & Christian, 2009), but high response rates maximize the sample size (Fox, Crask, & Kim, 1988) and minimize nonresponse bias, which can threaten the validity of a study's conclusions (Flick, 1988; Groves & Peytcheva, 2008; Shih, 2008). Meta-analyses spanning different topics and methodologies estimate response rates in self-report research to be less than 50% (Baruch, 1999; Baruch & Holtom, 2008; Yu & Cooper, 1983). Repeated measures research is particularly vulnerable to low response rates due to increasing attrition as studies progress (Little, 1995). Response rates in research using SMS for repeated measures also vary widely, from just 23% (Mutua et al., 2012) to 100% (Donaldson, Fallows, & Morris, 2014), but no investigation has examined what may be influencing these different rates.

Response completeness is reduced by skipping items or sending an unfinished response (Sax, Gilmartin, & Bryant, 2003). This may be due to accident or oversight, with participants unsystematically missing questions. It can also be intentional, if participants choose to not answer a particular question. Whether unsystematic or systematic, incompleteness can be problematic where total scores need to be calculated, and when the analysis of choice is not robust to missing data (Mogensen, 1963; Van Buuren, 2010). Perhaps due to the small size of the mobile telephone screen necessitating scrolling between reading and answering questions, SMS responses tend to be less complete than their paper counterparts (Gold et al., 2011). Another contributing factor may be participant burden. Thus overly burdensome sampling schedules could lead to less complete responses.

The delay between when a response is requested and when it is given is also important. In the case of data collection using SMS for research, response delays may be due to participants being away from their phone and thus unaware an SMS has arrived, or participants choosing not to respond immediately. The shorter the delay between when a response is prompted and when it is received, the less scope there is for recall bias to distort results. Self-report research using SMS has encountered a range of response delays, from an average delay of 2 min (Conner & Reid, 2012) up to 60 min (Lepper, Eijkemans, Beijma, Loggers, & Tuijn, 2013). While long delays may not be problematic for all research, it is desirable to minimize delay if the researcher is seeking to measure momentary experience (e.g., current mood).

The association between time of day and response behavior has generally focused on telephone interviews. Researchers are generally urged to contact people when they are likely to be at home and available – outside of business hours (D'Arrigo, Durrant, & Steele, 2009). These specific recommendations may not apply to SMS, because a voice call is typically taken or ignored as it arrives, while an SMS message may be left in the receiver's inbox to be dealt with at their discretion. This asynchronous nature of SMS is often used to provide thinking time in everyday SMS usage (Rettie, 2009), and may allow participants more flexibility in responding. However, this flexibility may cause response delays and missing responses due to participants forgetting that the SMS has been received. Therefore, the logic that time of day may be associated with availability and thus response behavior, may still hold for collecting data via SMS.

This experiment explored how the temporal factors of sampling frequency, prompt spacing, and time of day impacted on response rate, completeness, and delay in signal-contingent self-report repeated measures sampling using SMS. The study paradigm was designed with these methodological questions in mind, and used a short six-item questionnaire with a mixture of question types (binary, Likert, and open-ended). The topic of questions was mental time travel (e.g., remembering a previous meal or anticipating an upcoming social event). It was hypothesized that more frequent sampling and closer prompt spacing would be associated with lower response rates and less complete responses, and shorter response delays (as longer delays are more likely to result in responses being missed altogether). While there is some indication that availability may be related to response, it is not known how time of day will influence SMS response.

Method

Participants

Eighty-five undergraduate students in Australia, aged 17–46 ($M = 21$, $SD = 5.38$), 74% female, participated in return for course credit.[1] To standardize the response

[1] In accordance with the ethical principle of provision for withdrawal without penalty, this incentive was not contingent on full completion of all prompts: Course credit was offered regardless of response rate.

experience, a condition of participation was ownership of an iPhone.

Materials

Participants completed two computer-administered questionnaires: an initial demographic information instrument and an exit instrument reflecting on the participation experience. The ongoing participation consisted of a six-item self-report instrument with a mix of question types. The questionnaire was designed to explore methodological issues but was part of a larger study on mental time travel.

The repeated measures questionnaire consisted of (1) a Likert-style rating of current mood, on a scale of 0 = *poor*, to 5 = *good*; (2) a categorical nomination of current temporal orientation of thoughts (remembering/knowing/present/imagining/future thought/other); (3) a binary yes/no response to whether participants intended to do anything based on current thoughts; (4) an open-ended question asking for more information about plans; (5) a categorical nomination of current location (home/work/university/transport/other); and (6) a categorical nomination of the presence of other individuals (alone/with others and not engaging with them/with others and engaging with them). The full questionnaire was sent via SMS to participants once. Prompts to complete it consisted of the text "Please complete the MTT questionnaire. Questions? Email [researcher's email]." As all participants used iPhones, which organize incoming SMS according to number, upon receiving each prompt, participants scrolled to the top of the conversation and replied to the original SMS.

Procedure

Data collection took place in 2011 and 2012. Participants met with the researcher to complete the initial computer-administered instrument. At this time, they confirmed they owned an iPhone and had sufficient credit to send the SMS required by the study, and provided their mobile telephone numbers. The researcher sent all participants an SMS containing the six-item questionnaire, and informed participants they would each receive 20 SMS prompts sent between 8:00 a.m. and 10:00 p.m., on weekdays only, on a randomized schedule. Participants were informed of whether they would be participating in the 1- or 2-day condition. They were asked to respond as soon as possible by replying with their answers. Research has demonstrated successful sampling at 15 min (Ebner-Priemer & Kubiak, 2007), so this was chosen as the shortest interval; however, because we did not want to influence participant expectations, this minimum interval was not disclosed.

Data collection began with all participants responding across 2 days, receiving 10 prompts per day (a total of 20 prompts across 2 days). When preliminary analyses indicated unexpectedly high response rates, the researchers chose to add a condition of higher sampling frequency, where participants would receive 20 prompts over a single day. While random assignment to responding across 1 or 2 days would have been ideal, the exploratory nature of this research and discovery of an unexpected capacity for a compressed sampling frequency made this unfeasible. This resulted in all participants first recruited being assigned to the 2-day condition. Those recruited after the decision to change sampling frequency were assigned to the 1-day condition. The larger number of participants in the 2-day condition reflected the fact that the 1-day condition was added relatively late in the data collection process. Participants were unaware of the two different sampling schedules when signing up for the study. Aside from sampling across 1 or 2 days, all other aspects of the method (recruitment, instructions, and questions) were identical across the two groups. Once repeated measures data collection was complete, participants met once again with the researcher to complete the computer-administered exit questionnaire. At this point, those not on unlimited texting plans were reimbursed for the cost of sending reply SMS in the course of participation.

Results

A series of general linear multilevel (also known as hierarchical) models with response behavior nested by participant was used. Where any variable of interest was missing, that observation (i.e., particular time point for a particular participant) was removed from analysis. Significance of predictors was established by comparison of the model fit with and without the predictor (χ^2), and bootstrapping to create 95% confidence intervals (95% CI) around the slopes (at 10,000 replicates). Response time variables (response delay, and time since last response) were log transformed for analysis due to skewness and bounding.

Given that some attrition may be expected (Little, 1995), responses were examined for systematic degradation of response rates as the study progressed, to establish whether sampling occasion (1 through 20) would need to be controlled for in subsequent analyses. There was no evidence of attrition over the course of the study (Figure 1), and in all cases, adding prompt spacing or time of day to models containing sampling occasion as a predictor led to significantly better fit (at $p < .001$). This indicated that systematic attrition did not need to be controlled for by adding sampling occasion as a covariate into subsequent analyses.

Response behavior was examined in terms of response rates (the number of prompts receiving a response), response completeness (the percentage of questions answered among responses received), and response delay (the number of minutes between sending a prompt and receiving a response). Those responding across 2 days (n = 62, 74% response rate, with mean completion 63% and 14-min delay) and 1 day (n = 23, 78% response rate, with mean completion rate 70% and 11-min delay) did

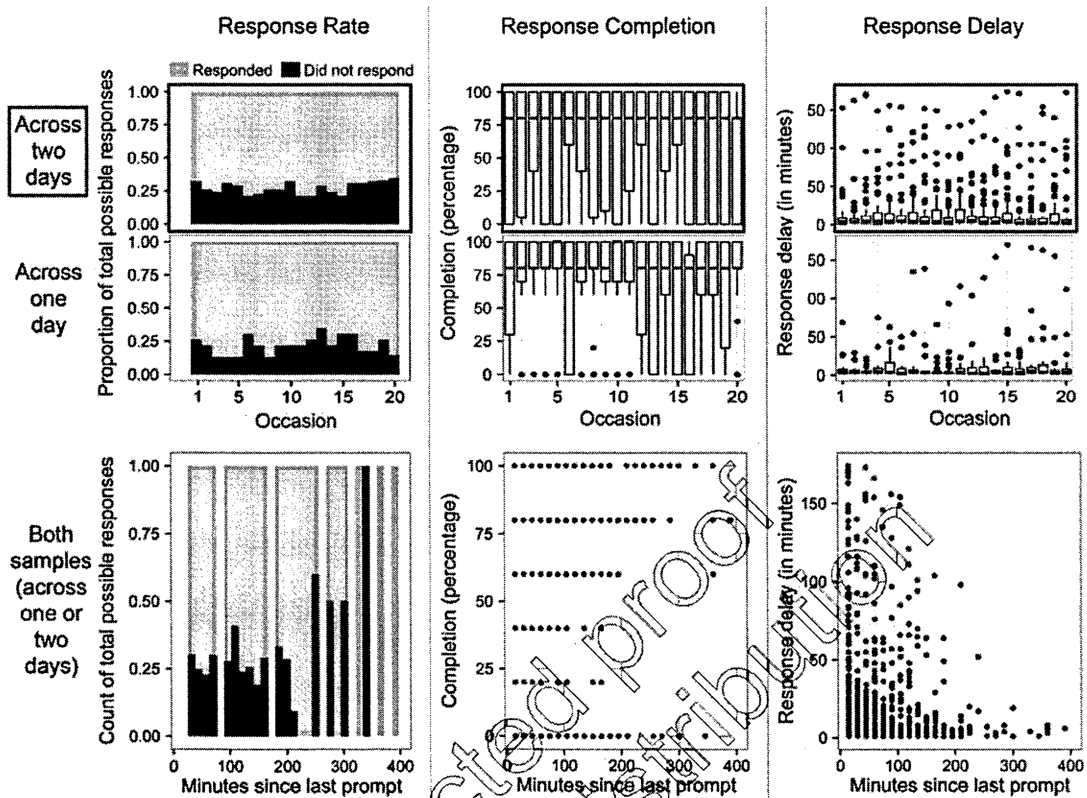

Figure 1. Response behavior, by sampling occasion (top row) and by prompt spacing (bottom row). Separation by sampling across 1 or 2 days in the top row demonstrates similarity in response behavior across different sampling frequencies. The y-axes in the second row have been truncated at 400 min in the interests of readability; outliers of up to 800 min were present.

not significantly differ in terms of response rates, percentage completion, and response delays (Figure 1), $\chi^2(1) = 1.03$, $p = .31$; $\chi^2(1) = 1.34$, $p = .25$; and $\chi^2(1) = 1.03$, $p = .31$, respectively. The intraclass correlation coefficient (ICC) for a logistic nested model, calculated as in Zeger, Liang, and Albert (1988), revealed a vanishingly small advantage gained by nesting data by whether participants samples across 1 or 2 days (ICC < 0.01). Accordingly, it was not included as a covariate or grouping variable.

Prompt spacing did not have a significant effect on response rates, completeness, or delay. As specific ranges in time may be associated with different response behavior patterns (e.g., workday vs. evening), regression trees (with a liberal .0015 complexity cutoff) were used to find split points within the data, to bin time into meaningful groupings. In the following models, time of day was added as a predictor to models already containing prompt spacing. There was no relationship between the time of day a prompt was sent and response rates, or with response delay; the regression tree indicated no split points, and adding time as a continuous predictor did not significantly improve model fit, $\chi^2(1) = 3.4$, $p = .07$. Neither was there a relationship between time of day and response delay: Adding time binned into seven categories (as indicated by the regression tree) as a predictor did not significantly improve model fit, $\chi^2(7) = 7.2$, $p = .409$.

There was a significant relationship between time of day and response completeness. Regression trees of this relationship revealed four split points, resulting in five bins which we arbitrarily named according to time or most likely activity: morning (8:00 a.m. – 8:30 a.m.), day (8:30 a.m. – 4:30 p.m.), early afternoon (4:30 p.m. – 6:00 p.m.), late afternoon (6:00 p.m. – 6:45 p.m.) and evening (6:45 p.m. – 10:00 p.m.). The mean percentage completion for morning responses was 40%, for day 66%, for early afternoon 60%, for late afternoon 71%, and for evening 60%. Adding these bins as a predictor of percentage completion significantly improved model fit, $\chi^2(4) = 16.379$, $p = .002$. Commute and evening responses were significantly less complete than day responses ($b = -7.49$, 95% CI [−12.57, −2.46]; and $b = -5.69$, 95% CI [−10.00, −1.40], respectively), but morning and afternoon responses did not significantly differ from day responses.

Discussion

This study explored the impact of sampling frequency, prompt spacing, and time of day on SMS response behavior in a signal-contingent self-report repeated measures paradigm. Response rates were higher than the average 50% response rate estimated in the wider psychological literature (Baruch, 1999; Baruch & Holtom, 2008; Yu & Cooper, 1983), and surprisingly did not exhibit the expected attrition given the repeated measures nature of sampling (Little, 1995). Though the lack of attrition across sampling occasions may be due to the relatively short time frame of sampling and thus would not hold for research undertaken over a longer time period, the high retention rate is promising for using SMS for intensive sampling. This suggests that SMS is a viable data collection tool for research where frequent self-report data is required.

Overall, responses were prompt, if not quite as quick as the 2-min turnaround of Conner and Reid (2012). This was likely due to the longer instrument used in the current study. It should be noted that the current study could not comment on whether delays were due to participants not seeing the prompt or because they chose to wait to respond. As accidental or active choice to delay responding may have different impacts on response quality, this issue should be investigated further. For example, evening responses were significantly less complete than day responses and this may have been due to participants being asleep and thus missing incoming SMS. Regardless of the cause of response delay, this indicates that researchers considering SMS as a tool for self-report data may expect low response delays. This is of particular utility in areas where retrospective recall bias or intervening events may diminish the validity of self-report data, as may be the case in recording of passing thoughts or of emotions.

In line with the literature, there was a potentially problematic number of incomplete responses (Gold et al., 2011). This problem could be addressed in a number of ways. Firstly, one could simply avoid collecting data at times known to be problematic. The relationship between completeness and time of day is informative, as it suggests that researchers working with an undergraduate sample are likely to maximize the completeness of responses by avoiding times when participants may be traveling and evenings, where possible. Future research could build on the association between response completeness and time of day by examining nonundergraduate samples, as, for example, it is quite likely that working hours would be unsuitable for a professional adult population. Another possible solution to this problem is alternative data collection methods that are similar to SMS but can prevent submission of incomplete responses, such as mobile applications or app-like website environments. Forced response completeness raises ethical concerns by removing the capacity to refuse to answer particular questions. Reminder messages which highlight unanswered questions, but allow the participant to move on, are an alternative which may improve response rates without raising ethical concerns.

The hypothesis that more frequent sampling and closer prompt spacing would be associated with lower response rates and less complete responses, but shorter response delays, was not supported. The indication that higher sampling frequency (and associated closely spaced prompts) does not adversely impact on response behavior is promising. Firstly, the current results suggest that SMS can be a very useful tool for research regarding constructs known to fluctuate on the order of minutes – for example, mood (Cranford et al, 2006). Secondly, it leaves considerable scope to see how far a researcher can push the sampling frequency and prompt spacing before response behavior breaks down. Such investigation should be mindful of ethical considerations of response burden and intrusiveness of repeated questioning, and physical possibility (as prompt spacing must exceed the time it takes to type a response). This relates to both the sampling frequency and the length of the instrument to be completed. It would also be useful to establish how the length of the instrument may impact on the relationship between sampling frequency and response behavior, keeping in mind that surprisingly lengthy instruments (10 or more items) can be administered via SMS (Walsh & Brinker, 2014).

Though this study was explicitly designed to address broad methodological issues, the generalizability of results is still somewhat bound to the particular questions asked. For example, open-ended questions take physically longer to type than multiple-choice questions, and questionnaires with more open-ended questions may expect longer delays. The particular topic may impact on many aspects of response behavior, including response rates (Cook et al., 2000), where difficult or sensitive questions may translate into greater participant burden and thus lower response rates (Bolger, Davis, & Rafaeli, 2003; Ebner-Priemer & Kubiak, 2007). Generalizability is further limited by the choice to use an undergraduate sample, and limiting respondents to those using iPhones. Despite these limitations, this study sheds some light on what prospective research using SMS may expect, and is a useful beginning for further investigation of sampling frequency when using SMS for self-report data collection.

This experiment explored how sampling frequency, prompt spacing, and time of day impacted on response rate, completeness, and delay. The remarkably low attrition and lack impact of sampling frequency on response behavior suggest that SMS can be a useful method when the researcher wishes to track a self-reported phenomenon across frequent sampling occasions. However, response incompleteness is a potential drawback which is difficult to address without turning to other modes, such as mobile apps. SMS, through lengthier instruments, more frequent sampling, and longer sampling durations. This study constitutes the first step in investigating the impact of temporal factors on response behavior when collecting signal-contingent self-report data SMS. By systematically varying elements of the current study design, such as sample, topic, question format, and sampling frequency, future research can build a valuable framework to guide the application of SMS as a tool for data collection.

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As you Likert – cross-mode equivalence of administering lengthy self-report instruments via text message

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One of the most widely used data services worldwide, Short Messaging Service (SMS) offers an unprecedented opportunity for researchers to communicate with participants at any location, or time. One concern when using SMS for research is whether the mode's brevity may make it unsuitable for administering multi-question, self-report psychological instruments originally developed for paper or online administration. Across two studies, this paper explores the psychometric properties and cross-mode measurement invariance of self-report, likert-style psychology questionnaires administered via SMS. The first study (*n*=417) examined this using different length variants of the same instrument, while the second (*n*=911) used instruments of varying lengths. Results demonstrated that, whilst some questionnaires were problematic, a self-report likert-style instrument as long as sixty items can be administered by SMS, with comparable response rates, internal reliability, and factor structures to online administration. However, in instruments over ten items in length, mean responses tended to be higher, leading to lack of equivalence in terms of latent means and intercepts.

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A measure is invariant if individuals with the same standing on a construct receive the same score on an instrument intended to measure that construct (Schmitt and Kuljanin, 2008). Undesirable variance can occur where the same instrument is given to populations who engage with it in a different way (e.g. Wicherts, Dolan, and Hessen, 2005), or where the researcher seeks to compare scores from different versions of an instrument administered to different groups. This can happen when participants respond to researchers using multiple modes, such as web, online or email self-report surveys being used in parallel (Dillman, Smyth, & Christian, 2009). Recently, cross-modal invariance is becoming important as mixed-mode research becomes more common (De Beuckelaer & Lievens, 2009), and new modes offer unique research opportunities (Cocco & Tuzzi, 2012). One such new mode is short message service (SMS), a ubiquitous text-based functionality of mobile telephones. One of the most widely used data services worldwide (Kuntsche & Robert, 2009), most Australians use SMS daily (Mackay & Weidlich, 2009). This is an unprecedented opportunity for researchers to communicate with participants at any location, or time (Haller, Sanci, Sawyer, Coffey, & Patton, 2006). The practicality of using SMS for research has been improved by the emergence of online bulk services that allow researchers to cheaply schedule SMS in advance to an arbitrary number of participants (Steeh, Buskirk, & Callegaro, 2007). Exploration of the cross-modal validity of using SMS as a tool for research can build upon techniques used and issues raised by previous cross-mode research.

Cross-modal measurement invariance research peaked during the transition from paper to online-based administration of questionnaires, commonly applying multi-group confirmatory factor analysis to compare the equivalence of instruments administered via different modes (e.g. Leung & Kember, 2005; Richardson &

Johnson, 2009; Schmitt & Kuljanin, 2008; Vecchione et al., 2012). Web and paper administration of the same questionnaires have been found to be equivalent across many topics, including in-class teaching feedback (Leung & Kember, 2005), depression (Yu & Yu, 2007), perceived stress and depressive thinking (Herrero & Meneses, 2006), tobacco dependence (Richardson & Johnson, 2009), and organisational engagement (De Beuckelaer & Lievens, 2009). Few investigations found differences in terms of underlying factor structures of paper versus online administration, but this has been observed (e.g. Hirai, Vernon, Clum, and Skidmore, 2011). The most commonly reported effect of mode on measurement equivalence relates to mean responses, with web questionnaires tending to have systematically higher scores in general (Vecchione et al., 2012), and subsequently higher latent mean scores (Cole, 2006; Meade, Michels, & Lautenschlager, 2007).

To date, the possibilities of administering relatively lengthy self-report instruments via SMS have not been explored. Though there are some examples of single administrations of longer instruments via SMS (e.g. Lee et al., 2013), SMS tends to be used for brief self-report measures specifically designed for repeated administrations, typically the same few likert-style questions per sampling occasion. This is likely because of the inherent brevity of SMS as a communication tool. The 160 character-per-message has historically restricted how much information could be provided in an SMS. As SMS technology develops, the 160 character per message limit has been bypassed by support for stitching multiple SMS together. This allows for much longer SMS communications. The longest instruments administered via SMS in the literature currently stand at 23 (De Lepper et al., 2013) and 24 (Lee et al., 2013) items. There is evidence from research with other modes that the length of a questionnaire can meaningfully impact participant engagement (Dillman et al., 2009) and in turn, data quality and response rates (e.g. Burchell & Marsh, 1992; Jepson et al. 2005; LaMar & Gale, 1982). One factor in this is whether the instrument is presented all at once, or broken across mutliple pages or screens (Cocco & Tuzzi, 2012). Cross-modal comparisons involving SMS use instruments too brief to explore these issues, because there are too few items to be amenable to a factor analysis. Instead, such investigations typically focus on response rates, participant feedback, and use descriptive statistics for comparison.

Repeated SMS measures have correlated with prospective online baseline questionnaires (Lim, Sacks-Davis, Aitken, Hocking, & Hellard, 2010), and retrospective telephone interview self-report measures (Johansen & Wedderkopp, 2010; Whitford et al., 2012). A large scale survey of influenza vaccination coverage found comparable odds ratios of vaccination within those surveyed via telephone interview or SMS (Bexelius et al., 2009). Physical activity diaries completed via online, paper and SMS diaries were similar in terms of mean physical activity reported (Lagerros, Sandin, Bexelius, Litton, & Löf, 2012; Shapiro et al., 2008). Comparison between SMS and app administration of a serious mental illness assessment revealed similarly congruent results in terms of descriptive statistics (Ainsworth et al., 2013). Though this is promising, there are several reasons to suspect that SMS responses may not be equivalent to online or paper counterparts when administering pre-existing questionnaires.

The visual presentation of a self-report instrument is important (Dillman et al., 2009; Richardson & Johnson, 2009), impacting response rates (Jansen, 1985) by affecting how difficult it is to read questions (Smith, 1993), and the length of a response (Fuchs, 2009). Due to the size of mobile telephone screens, questions sent via SMS will almost invariably be presented in a smaller, more cramped format than those presented online, or by paper. This may lead to participants missing items when responding via SMS, particularly for longer instruments where the SMS received will be particularly dense. The way in which a response is recorded also differs across modes in a way that may impact upon response rates – the experience of typing on a QWERTY smartphone touchscreen is more clumsy than using a full-sized computer keyboard (Page, 2013), or writing with a pen. This may lead to mistakes that threaten the internal reliability of an instrument, such as entering a '5' when the next along,'4', was intended.

The greater difficulty associated with reading and responding to questions, the greater the participant burden, which in turn impacts on response rates and attrition (Bolger, Davis, & Rafaeli, 2003). Where participants anticipate too high a burden, they are likely to drop out. Comparative response rates across modes are an important consideration (Leung & Kember, 2005). Problems in recruitment, or pre-inclusion attrition (where participants drop out between recruitment and active particiaption) can indicate problems and limits of a methodology (Cook & Campbell, 1979). There is little point establishing the validity of a mode if participants are unwilling to use it, particularly if it is being compared to other modes with established, generally accepted, response rates (e.g. self-report research carried out on line has an estimated approximate 40% response rates; Cook, Heath, & Thompson, 2000; Shih, 2008).

One of the greatest strengths of SMS as a research mode – the ability to contact participants regardless of their location – may also be a weakness, in that the researcher has no control over what distractions may be present as a participant responds. A noisy environment can disrupt attention (Banbury & Macken, 2001), and may lead to disengagement and perhaps even premature submission of an incomplete response. This would scale with the length of the instrument, as the greater the number of items, the more opportunity there is for missingness. Participants are very unlikely to complete a paper or online instrument in noisy settings, such as on public transport or at the pub, but may well attempt an SMS response in those locations. This could lead to greater missingness of SMS responses in comparison to other modes.

The current state of SMS technology, and the formative state of the literature relating to the measurement invariance of using SMS to administer pre-existing psychological instruments, begets two interrelated questions. Firstly, to what extent does administration via SMS impact upon the psychometric properties of pre-existing psychological instruments? Secondly, how many questions may be asked via SMS before response rates and psychometric properties are compromised? Over two studies, this paper explores cross-modal invariance of Likert-style instruments of varying lengths administered by SMS in comparison with online and paper administrations.

Analytical approach

There are many different ways to analyse measurement invariance (Borsboom, 2006). The current approach combined statistics used in the literature to evaluate the quality of SMS data, and the factor-analytic technqiues used elsewhere in the cross-mode invariance literature. Comparison began by looking at response rates (RR), and usable response rates (UR; i.e. completing all constituent items with responses within the appropriate ranges). Scored instrument means were compared by Welch two sample t-tests. As the distribution of scores are also informative (Herrero & Meneses, 2006; Hirai et al., 2011), Anderson-Darling k sample tests (with 1000 simulated replicates) were used to establish whether the score distributions were significantly different. Internal reliability was evaluated by Chronbach's alpha (as in Herrero & Meneses, 2006; Hirai et al., 2011; Leung & Kember, 2005).

As recommended by Leung and Kember (2005), feasability of results was established by comparison with factor structures reported in the literature. The factor structure suggested by visual inspection of scree plots and variable factor maps for each mode was evaluated by model fitting and inspection of χ^2 tests of whether the number of factors specified were sufficient. Following the recommendations established by Vandenberg and Lance's (2000) synthesis of the measurement invariance literature, multi-group confirmatory factor analysis was then carried out, primarily using the semTools package in R (Pornprasertmanit, Miller, Schoemann & Rosseel, 2013). First, a baseline model with the same factor structure for both groups is fit to the data. This test of *configural invariance* evaluates whether the same factor structure is appropriate for both groups. Subsequent models are compared with this model. Measurement invariance is supported if the models do not significantly differ in fit from the configural invariance model (denoted by a non-significant $\delta\chi^2$), but do significantly fit the data (indicated by significant χ^2). *Metric invariance* (also known as 'weak invariance') tests whether the factor loadings are equivalent, by constraining them to be the same across groups. *Scalar invariance* tests whether the factor loadings and intercepts are equivalent by constraining them to be the same across groups. If metric and scalar invariance are present, a final test, *general factor invariance,* constrains factor loadings, intercepts and means to be the same across groups – a significant χ^2, and non-significant $\delta\chi^2$ for this test provides strong evidence for equivalence.

Study 1

The aim of this study was to investigate the cross-modal measurement invariance of administering instruments of varying lengths via SMS, as opposed to paper. To this end, short forms of the Ruminative Thought Styles questionnaire (RTS; Brinker & Dozios, 2009) were constructed.

Participants

Participants were 417 undergraduate students aged 17-66 (M=22), 53% female. 42 were assigned to complete the five item RTS (20 via paper, 21via SMS), 46 the ten item version (20 via paper, 26via SMS), 46 the fifteen item version (20 via paper, 26 via SMS), and 283 the original twenty item RTS (120 via paper, 163 via SMS). Participants responding via SMS were recruited by way of posters. Those responding via paper were recruited in person upon completion of other experiments, or at a table outside lecture halls. All participants were offered thirty minutes course credit as an incentive, regardless of the version or the mode used to respond.

Materials

The RTS (Brinker & Dozios, 2009) is a self-report rumination questionnaire with 20 items loading on a single factor. Responses are given on a likert scale of 1 through 7. Three short form versions (fifteen item, ten item, and five item) of the RTS were created for the purposes of this study. The short forms were created by pooling RTS data from eight past studies with university undergraduate samples. Following analyses confirming homogeneity of RTS and demographics across samples (mean participant age=26, *SD*=16.66, 34% male), the short form versions were constructed by iteratively dropping the items to maximise Chronbach α and single-factor loadings. The resultant short forms had good internal consistency, with α ranging from .86 through to .93.

The original RTS instructions direct respondents to circle the correct number corresponding to each item, which is untenable via SMS. An alternate method of responding amenable to SMS completion was developed:

> *"For each of the RTS items, rate how well the item describes you, with 1 indicating not at all, through to 7 indicating very well. Indicate which question you are responding to, a full stop, and then your answer. Separate each question with the letter x. Answer all of the questions in order. Example: "1.3x2.5x3.5" etc."*

To control the differences in response experience across modes, the short form versions of the RTS administered by paper were given the same response instructions as those administered by SMS. So, when responding by paper, participants wrote their answers in the same format as provided in the example above. To establish whether this change of instructions affected responses, some (n=20) participants completed the twenty item RTS with the new instructions, while the rest (n=100) completed it using the original RTS instructions. All participants using the new instructions were asked to rate the difficulty of writing their responses on a scale of 0 (very difficult) to 5 (very easy).

Design and Procedure

This pseudo-experiment used a 2 (modes) x 4 (length versions) design. For practical reasons, response mode was not randomly assigned. This was because the physical presence of students on campus at the time of completing the questionnaire was required for paper completions (as participants had to obtain the survey, complete it, and then return it in person), but not SMS completions (as participants could provide their contact details and then leave). Recruitment for SMS and paper versions was carried out simultaneously, but separately. The two response modes were advertised as though they were separate and mutually exclusive studies, with participants effectively self-selecting which mode they would use depending on which study they signed up to. Assignment to length version group was random.

Those responding via SMS indicated their consent by texting "yes" and a time and date they preferred to respond. Instructions for completing the RTS were sent at the designated time, followed by the items fifteen minutes later. Due to the length constraints of SMS, the instrument was sent in five item chunks scheduled to arrive at the same time (i.e. the twenty item version was split across four messages). Demographic and feedback questions were sent the day after the questionnaire. Those responding via paper collected the RTS from the researcher, returning it anonymously by way of a submissions box.

Results

Response rates were relatively high and consistent across the ten, fifteen and twenty item versions, with no clear trend in terms of item missigness diminishing usable responses as the number of items increased (Table 1). While the five item version demonstrated a much higher response rate and usable response rate than the other length versions, it did not demonstrate cross-mode equivalence. SMS and paper administrations of the five item version differed significantly in terms of means, distributions, and underlying factor structure (Table 1, Table 2), precluding further multi-group factor analysis. Inspection of the communalities, the proportion of variation in the items explained by the factors specified, can indicate whether a particular item is responsible for poor model fit. Ideally, communalities should approach 100 (indicating all variance in a given item is explained by the factor). Different items were problematic in the SMS and paper responses; item 5 was the most problematic in SMS with a commonality of just 2, whilst item 3 was most problematic in paper with a commonality of just 10. Post-hoc analysis of participants completing the five item version found that those completing the instrument via paper were significantly younger than those via SMS (paper mean age = 21, SMS = 34, $t(20)=4.101, p<.001$).

Table 1. Missingness, descriptive and internal consistency comparisons between modes

RTS			SMS			Paper			t	pK
Version	RR	UR	M	SD	α	M	SD	α		
5	99%	90%	21.25	5.6	.79	24.56	3.55	.67	2.19, p=.03	.029
10	73%	57%	47.32	10	.68	42.67	8.55	.89	1.41, p=.17	.397
15	76%	73%	66	16	.88	60	15	.90	1.25, p=.21	.193
20	73%	67%	84.81	20	.91	88.45	17.82	.90	1.45, p=.15	.22

Note. RR = response rate, the percentage of participants who at least partially completed the SMS instrument. UR = usable response rate, the percentage of participants who correctly completed all items of the SMS instrument. A pK value less than 0.05 signifies a significant result for the Anderson-Darling k-sample test, indicating the scale's total scores come from different underlying distributions depending on mode.

The longer ten, fifteen and twenty item versions of the RTS had consistently excellent internal consistency comparable with online completions (α>.85). Reasonable SMS response rates (≈73%) diminished somewhat by item missingness within responses, particularly due to out-of range responses. Once scored, there were no significant mean or distribution differences between SMS and paper administration of the ten, fifteen, or twenty item versions of the RTS (Table 1). Multi-group factor analysis confirmed configural, metric, scalar and general factor invariance across modes of administration for all length versions but the shortest (Table 2).

Participants using both SMS and paper generally rated the process of writing the text to respond as easy (a median rating of 4 for both groups), and there was no significant difference in this rating between modes, $t(157)$=.77, p=.44. Participants responding via paper using the original or SMS-version RTS instructions did not significantly differ in terms of RTS score mean or distribution ($t(21)$=1.55, p=.135; AD=1.83, p=.111). Due to this, analyses of the twenty item version of the RTS proceeded by pooling both original and new instructions under the category of 'paper' responses. ANOVA revealed there was also no significant difference in reported difficulty of responding between participants completing the different length versions via SMS, $F(3)$=.062, p=.98.

Table 2. Multi-group factor analysis outcomes

Version	Model 1 (Configural invariance)	Model 2 (Metric invariance)	Model 3 (Scalar invariance)	Model 4 (General Factor invariance)
5	$\chi^2(340)=12.483$, $p<=.254$	-	-	-
10	$\chi^2(70)=113$, $p<.001$	$\chi^2(79)=128$, $p<.001$ $\delta\chi^2(9)=14$, $p=.09$	$\chi^2(88)=138$, $p<.001$ $\delta\chi^2(18)=25$, $p=.125$	$\chi^2(89)=140$, $p<.001$ $\delta\chi^2(19)=27$, $p=.09$
15	$\chi^2(180)=425$, $p<.001$	$\chi^2(194)=432$, $p<.001$ $\delta\chi^2(14)=7.073$, $p=.904$	$\chi^2(208)=443$, $p<.001$ $\delta\chi^2(28)=18$, $p=.929$	$\chi^2(209)=44$, $p<.001$ $\delta\chi^2(29)=19$, $p=.922$
20	$\chi^2(340)=1019$, $p<.001$	$\chi^2(359)=1034$, $p<.001$ $\delta\chi^2(19)=15$, $p=.713$	$\chi^2(378)=1067$, $p<.001$ $\delta\chi^2(38)=48$, $p=.125$	$\chi^2(379)=1069$, $p<.001$ $\delta\chi^2(39)=50$, $p=.112$

Discussion

Overall, cross-mode translation had little impact on the psychometric properties of the RTS. Ten, fifteen, and twenty item versions all conformed to the single factor structure established during the creation of the RTS by Brinker and Dozios (2009), and were consistently invariant across modes. The shorter versions provided no benefit in terms of response rates or psychometric validity, suggesting no significant detriment to administering the longer, twenty item version via SMS.

Only the shortest variant was problematic, demonstrating higher response rates at the cost of psychometric stability. The lack of equivalence across modes may reflect a genuine difference, as rumination does change with age (Sütterlin, Paap, Babic, Kübler, & Vögele, 2012). It is most likely that the lack of equivalence between the five item versions of the RTS administered on paper and via SMS is an artefact of the combination of having a relatively small sample, and having so few items available for analyses. Smaller samples are generally less stable than larger ones, as they allow more scope for outliers to distort mean tendencies and distributions. Instruments with more items tend to be more stable than their counterparts for the same reason. As factor analysis is sensitive to these issues, factor models become more stable (and thus more useful) with an increasing sample size, and an increasing number of items loading on the proposed latent factors (Tabachnick & Fidell, 2007). This is not always a concern, however the presence of low commonalities alongside small sample sizes, and small number of items loading on factors, inflates error terms and thus undermines the validity of the factor models (MacCallum & Widaman, 1999).

Though promisingly high response rates were diminished by missing items, all length variants compared favourably to current estimates of approximately 40% response rates for online self-report research (Cook, Heath, & Thompson, 2000; Shih, 2008). Response rates were notably consistent across the longer versions, suggesting that the presumed increase in burden of a twenty, rather than ten or fifteen, item questionnaire is not sufficient to produce a significant impact on response rates. Results supported adapting response instructions to an SMS format with minimal disruption to the psychometric properties of responses. The general form of instructions used was effective.

Study 2

This second study extends on the previous by exploring cross-modal measurement invariance between SMS and online instruments, rather than paper. Online surveys have become the dominant mode in self-report research (Dillman et al., 2009). With the ubiquity of computer ownership and internet access, online questionnaires are beneficial as they tend to attract a broader sample than just university undergraduates participating in return for research credit (Gosling, Vazire, Srivastava, & John, 2000). This may also be the case for SMS research. Whilst the volume of psychology research undertaken with undergraduate participants makes it a good start point for examine the properties of a research mode, findings based upon an undergraduate sample has limited generalizability to the general population (Sears, 1986), in particular due to undergraduates having generally poorer mental health (Stallman, 2010). This study will therefore, in part, evaluate how well SMS performs when used with the general population.

Study 1 remained within the bounds of the longest instruments previously administered via SMS. The strong cross-mode equivalence of even the full twenty item RTS suggests further scope for pushing the boundaries of length when administering an instrument via SMS. As longer instruments tend to have more complex underlying factor structures, this allows exploration of cross-mode equivalence in scales with multiple factors. This will provide more scope for cross-mode differences in factor structures, loadings, means and intercepts, and thus prove a more stringent evaluation of the measurement invariance of administering an instrument via SMS.

Participants and materials

A total of 183 participants (57 via SMS, 126 online) were recruited to complete the 10-item negative axis of the Positive Affect Negative Affect Schedule (PANAS; Watson, Clark, & Tellegen, 1988). Aged 17-64 (*M*=22), 57% of this sample were female. All obtained research credit as part of a larger study. The SMS version of the PANAS was administered in one single text, as follows.

> *Instructions: Copy each word, then indicate to what extent you feel this way right now, that is, at the present moment. An example correct response = bipedal 5. Use the following scale: 1 = very slightly or not at all, 2 = a little, 3 = moderately, 4 = quite a bit, 5 = extremely. The ten words are: distressed * upset * hostile * irritable * scared * afraid *ashamed * guilty * nervous * jittery. Reply to this text with your response. Please check you have completed all TEN words before sending your response. Issues? Contact [researcher's email] Thanks!*

A different sample of ` (36 via SMS, 217 online) were recruited to complete the 16-item Acceptance and Action Questionnaire (AAQ; Hayes et al., 2004). Aged 17-70 (*M*=24), 75% of this sample were female. Despite possible problems with using an undergraduate sample for comparison, practical reasons resulted in the online sample being undergraduate students participating in return for course credit. The SMS portion of the sample were members of the general public, offered no incentive. The AAQ was administered across three texts (one instruction text, two texts for the scale proper).

> *Instructions: In 15 minutes you will be sent a list of statements. Please rate the truth of each statement as it applies to you. Use the following scale to*

make your choice: 1 = never true, 2 = very rarely true, 3 = Seldom true, 4 = Sometimes true, 5 = Frequently True, 6 = Almost Always True, 7 = Always true. To respond, reply to the final SMS with the letter and truth of each statement, i.e. A3 B1 C4 etc

In fifteen minutes time, participants received the questions in the following format:

A. I am able to take action on a problem even if I am uncertain what is the right thing to do. B. A person who is really 'together' should not struggle with things the way I do [etc]

A total of 84 participants (57 via SMS, 27 online) were administered the 42-item Depression Anxiety and Stress Scale (DASS; Lovibond & Lovibond, 1995). Aged 17-62 (*M*=21), 58% were female. The DASS was administered across six texts (one instruction text, five for the scale proper), using the same completion instructions as the RTS in study 1 (i.e. 1.5x2.6 etc). All participants were undergraduates receiving an incentive of course credit.

A total of 391 participants (124 via SMS, 267 online) were administered the 60 item Positive Affect Negative Affect Schedule – Expanded form (PANAS-X; David Watson and Clark, 1999). Aged 18-46 (*M*=21), 65% were female. The PANAS-X was administered across two texts (one for instructions, and one with the scale proper). Instructions were similar to those for the PANAS, but required fewer characters in the reply to compensate for the drastically increased instrument length.

PANAS-X INSTRUCTIONS - This scale consists of a number of words and phrases that describe different feelings and emotions. Read each item and then mark the appropriate answer next to that word. Indicate to what extent *you have felt this way during the past few weeks . Use the following scale to record your answers: 1= very slightly, 2 = a little, 3 = moderately, 4 = quite a bit, 5 = extremely. Reply with the first two letters of each word, and your answer, i.e. for cheerful=5 and sad=2, ch5 sa2. The words/phrases will be sent to you in 15 mins.*

To standardise the response experience as much as possible, online participants entered their responses for each item in text boxes, rather than select answers using a Likert matrix.

Design and procedure

This was a between-subjects correlational design. As in Study 1, those responding via SMS indicated their consent by texting "yes" and a time and date of their convenience to a number specified by the researcher, and were sent the instruction text at that time. The full questionnaires were then sent fifteen minutes later. Demographic information was collected in a follow-up text the next day. Those participating online indicated their consent via survey completion, and provided demographic information at the same time as completing the instrument.

Results

The response rate for the PANAS-NA was very high, as was the reliability of the scale completed via both modes. Responses completed via SMS had a significantly lower mean, and the distributions of the two modes significantly differed (table 3). This is due to a floor effect in SMS completion across most items – most SMS respondents answered with the lowest possible score for each item. As in the PANAS-NA norms (Watson et al., 1988), a single factor solution was sufficient for both modes. Multi-group factor analysis indicated configural but not metric invariance. Inspection of communalities reveals this is likely due to some problematic items in the SMS but not online factor structures. It is possible that the apparent high reliability and single factor structure from the SMS scores is due to the floor effect of consistently low scores across items, rather than reflecting the intended PANAS-NA structure encapsulated in the more varied online responses. There was not a significant difference in age between those completing the PANAS-NA via SMS or online, t(56)=1.94, p=0.06.

Turning to the AAQ, reliability was similar, and there were no significant differences in mean and distributions of total scores by mode (table 3). However, there was a significant (over 50%) non-response rate in those responding via SMS. Subsequent factor analyses should be interpreted with caution due to the small SMS sample size. Having established that a single factor solution was sufficient, multi-group factor analysis revealed that while SMS and online completions of the AAQ had configural and metric invariance, they did not have scalar invariance (table 4).

Table 3. Missingness, descriptive and internal consistency comparisons between modes

	N	RR	UR	SMS			Online			t *p*	K
Scale				M	SD	α	M	SD	α		
PANAS-NA	10	99%	88%	13	4	.80	21	8	.88	10.33, p<.01	<.01
AAQ	16	46%	43%	68	9	.70	66	10	.71	1.15, p=.25	.52
DASS	42	96%	42%	44	24	.96					
(depression)				15	10	.93	8	7.6	.88	2.45, p=.02	<.01
(anxiety)				13	9	.90	7	7.7	.92	2.57, p=.01	.05
(stress)				17	8	.87	6	3	.91	5.081, p<.01	.02
PANAS-X	60	83%	57%								
Negative affect	10			23	8	.86	15	5	.85	9.6, p<.001	<.01
Positive affect	10			31	7	.83	27	7	.86	5.87, p<.001	<.01
Basic negative emotion scales											
(fear)	6			13	5	.85	8	3	.82	8.12, p<.001	<.01
(hostility)	6			12	4	.77	8	3	.78	8.92, p<.001	<.01
(guilt)	6			14	5	.86	10	4	.80	6.59, p<.001	<.01
(sadness)	5			12	5	.87	9	4	.83	5.22, p<.001	<.01
Basic positive emotion scales											
(joviality)	8			26	6	.87	21	7	.93	6.97, p<.001	<.01
(self-assurance)	6			16	4	.74	14	5	.85	5.41, p<.001	<.01
(attentiveness)	4			13	3	.65	12	3	.68	2.13, p=.033	.09
Other affective states											
(shyness)	4			8	3	.58	7	3	.73	4.233, p<.001	<.01
(fatigue)	4			14	4	.80	10	4	.87	8.36, p<.001	<.01
(serenity)	3			9	3	.84	10	3	.81	2.44, p=0.01	.03
(surprise)	3			6	2	.55	4	2	.72	8.51, p<0.01	<.01

Note. RR = response rate, the percentage of participants who at least partially completed the SMS instrument. UR = usable response rate, the percentage of participants who correctly completed all items of the SMS instrument. A *p*K value less than 0.05 signifies a significant result for the Anderson-Darling k-sample test, indicating the scale's total scores come from different underlying distributions depending on mode.

Table 4. Multi-group factor analysis outcomes

Scale	N items	N factors	Model 1 (Configural invariance)	Model 2 (Metric invariance)	Model 3 (Scalar invariance)	Model 4 (General F. invariance)
PANAS-NA	10	1	$\chi^2(70)=221$, $p<.001$	$\chi^2(79)=257$, $p<.001$	-	-
				$\delta\chi^2(9)=36$, $p=.001$	-	-
AAQ	16	1	$\chi^2(208)=507$, $p<.001$	$\chi^2(223)=530$, $p<.001$	$\chi^2(238)=583$, $p<.001$	-
				$\delta\chi^2(15)=22$, $p=.1$	$\delta\chi^2(30)=76$, $p=.001$	-
DASS	42	3	$\chi^2(1632)=9939$, $p<.001$	$\chi^2(1671)=10054$, $p<.001$	-	-
				$\delta\chi^2(39)=115$, $p<.001$	-	-
PANAS-X (general dimensions)	60 (20)	2	$\chi^2(338)=847$, $p<.001$	$\chi^2(356)=864$, $p<.001$	$\chi^2(374)=990$, $p<.001$	-
				$\delta\chi^2(18)=17$, $p=.501$	$\delta\chi^2(36)=143$, $p=.001$	-
PANAS-X (subscales)	60 (40)	11	$\chi^2(2642)=5548$, $p<.001$	$\chi^2(2686)=5626$, $p<.001$	-	-
				$\delta\chi^2(44)=77$, $p=.001$	-	-

Across all three subscales, online completions of the DASS resulted in consistently, significantly lower scores, coupled with a more skewed, zero-bounded distribution than SMS completions (table 2). Online completions were closer to norms reported for a general population, whilst SMS were descriptively closer to norms reported for clinical populations (Lovibond & Lovibond, 1995). There was no significant difference in the age of those participating via online survey, or SMS $t(27)=1.87$, $p=.07$. As in the literature, a three factor solution (corresponding to depression, stress and anxiety subscales) was sufficient. Multi-group factor analysis revealed configural, but not metric invariance.

Despite an initially high response rate for the PANAS-X, widespread item missingness in SMS responses considerably diminished the number of usable responses. Despite this missingness, reliability was again relatively high across both SMS and online administrations. Showing an opposite pattern to the PANAS-NA, mean scores for SMS completions were higher than online completions for all but one PANAS-X subscale (the serenity subscale) (Table 2). The online PANAS-X scores were consistently closer to the norms reported by Watson and Clark (1999) than the SMS scores. There was a significant difference in age between groups, t=5.3091, p<.01, with SMS respondents being younger (*M* age 20) than online respondents (*M* age 23).

Due to the large number of factors present in the original scale, and floor effects in the online conditions, multi-group factor analysis of all sub-scales failed to converge. Analysis proceeded by dividing investigation into the 'classic' 20 item PANAS-NA/PA two factor structure, and the additional sub-scales established in the PANAS-X (as in Watson & Clark, 1999). The expected two-factor structure was appropriate for PANAS-NA and PANAS-PA items, with multi-group factor analysis indicating configural, metric, but not scalar invariance. Whilst the proposed factor structure for the other sub-scales was theoretically feasible, the model was too unstable for conclusions to be drawn.

Discussion

Overall, cross-mode translation significantly impacted upon the psychometric properties of the instruments in terms of means and latent structure. The PANAS-NA proved problematic in terms of cross-mode equivalence, with SMS responses considerably differing from their online counterparts, and what would be expected given the PANAS-NA norms (Watson et al., 1988). Though age may have played a factor in the cross-mode differences in the five item RTS in study 1, age of participants completing the PANAS-NA did not significantly differ by mode. Nor could the different scores be explained by differential social desirability effects stemming from contact with the researcher, as participants using both modes had the same contact with the researcher. Social desirability may have impacted responses as a function of response context. Due to their portability mobile phones are commonly used in public places (Wei & Leung, 1999), whilst online questionnaires are commonly attempted on more stationary personal computers in research laboratories, workplaces, or the home. This means that a participant using SMS for the purposes of research is more likely to receive the instrument when in a public setting (such as in a shopping mall, or in a restaurant) than one responding online. Perhaps participants were unwilling to honestly disclose the degree of their negative affective state whilst in a public setting, hence in the current study under-reported their negative affect. It is possible this effect is absent from the longer SMS instruments, because participants were willing attempt the briefer measure as the SMS arrived, but removed themselves from the company of others to focus on responding to the longer instruments. Future research could investigate this possibility by adding questions about current participant location and social surroundings at to the SMS instrument.

Just as past cross-mode investigations found web questionnaires tended to have systematically higher scores in general (Vecchione et al., 2012), so SMS scores were higher for the AAQ, DASS, and PANAS-X. These higher scores via SMS pulled the average away from zero, resulting in scores conforming to a more normal distribution shape than paper scores. Unexpectedly, the 16 item AAQ was the only scale demonstrating measurement invariance in terms of response mean and distributions. This is bemusing given that the comparison was between the general population and undergraduate students, and there is reason to believe the undergraduate samples should obtain poorer scores on instruments relating to mental health (Sears, 1986; Stallman, 2010). This apparent equivalence may be a consequence of the small SMS comparison group. In a review of response rates to paper questionnaires, Heberlein and Baumgartner (1978) noted that surveys administered to the general population are less likely to be returned than those given to specific subsamples, such as student populations. A meta-analysis of online survey response rates found that using an academic (including students and faculty) sample constituted a suppressor variable for other factors impacting on response rates, such as offering monetary incentives (Cook et al., 2000). Perhaps the comparably high response rate to SMS instruments administered to undergraduate samples is specific to that group, especially where course credit (an incentive unique to university student participants) is offered. Strategies known to improve response rates, such as monetary or token gift incentives (Dillman et al., 2009), may be required when administering instruments via SMS in the general population.

Cross-modal equivalence was only partially demonstrated in the instruments with multiple underlying factors. Support for metric and configural but not scalar or general invariance, suggests that though the general factor structure is preserved across modes, underlying distribution and mean-level differences translate into non-equivalent latent mean scores and intercepts. This is similar to previous findings that online administrations tend to have higher latent mean scores than paper administrations (Cole, 2006; Meade et al., 2007). It is not likely due to age differences between SMS and online samples; there was no difference in age for DASS completions, and though SMS PANAS-X respondents were statistically significantly younger than online respondents, the practical difference was small (just three years difference in mean age).

General discussion

The extent to which administration via SMS impacted upon the psychometric properties of pre-existing psychological instruments was somewhat associated with the length of the instrument. In study 1, cross-mode translation had little impact on the psychometric properties of the RTS, except for the shortest length variant, supporting the validity of administering the full twenty-item instrument via SMS. Study 2 revealed a similar pattern detected by research comparing paper and online administrations (Cole, 2006; Meade et al., 2007; Vecchione et al., 2012): though the factor structures were congruent with what would be expected from instrument norms, SMS scores were higher than their online counterparts for the AAQ, DASS, and PANAS-X. Compounded by distribution differences, this ultimately led to non-equivalence of the underlying factor means and intercepts. These differences were not due to age, and thus differential access to and aptitude with SMS technology. This, and the surprising mean-level equivalence of the instrument administered using different modes to different samples, suggests that the cross-mode variance present in administration via SMS stems from a property of the response mode itself, rather than different populations engaging with the instruments in different ways. If participants were responding via SMS in more public contexts than those responding via online or paper, and this caused under-reporting of negative attributes due to social desirability bias, one would expect SMS scores to be lower than those from other modes.

Another possible explanation relates to the visual layout of the instruments. When participants respond using a likert matrix, they are presented with a vertical list of questions and a horizontal array of tickable boxes corresponding to the response. In this way, the full range of possible responses for each question is always visible. In the first study, cross-mode equivalence was found when both SMS and paper respondents were asked to respond by writing their answers in a string of text, with neither mode using a likert matrix. In the second study, participants completing the AAQ and DASS online responded via a likert matrix, whilst those responding via SMS responded in text strings. The SMS responses therefore had no spatial representation of the range upon which to anchor their responses. This lack of an implicit visual anchor may have led to systematic differences in responses. However, despite this difference the AAQ scores were equivalent. Further, to control for such effects, the online administration of the PANAS-X did not use a likert matrix for responses, yet still demonstrated consistently lower scores than the SMS administration. It is therefore unlikely that this visual layout cue underlies the difference in scores found across modes.

In terms of response rates; different target populations engaged with SMS differently. In instruments administered to undergraduate samples, response rates to even the longer instruments exceeded expectations, but the response rate from the scale administered to the general population was on par with the 40% response rate estimated for online self-report research (Cook, Heath, & Thompson, 2000; Shih, 2008). Across all samples, missingness within responses was far more of a concern than response rates, considerably diminishing the amount of usable data. Degree of missingness was not linearly related to instrument length, as there was a sudden jump from low to high missingness between the shortest scale, and the others in each study. This is not likely due to possible environmental distraction when completing an SMS measure, as that would manifest in missingness scaling with the number of items (as each additional item provides another opportunity for a distraction to cause a missed response). The more probable explanation is the number of SMS needed to administer the questionnaire. Both the five item version of the RTS, and the PANAS-NA, could be sent in one single text. Responding therefore required less navigation between SMS, lowering participant burden and making it easier to read and remember the questions, thus improving response behaviour. This possibility needs to be explored in more depth, however, as participants responding to the longer instruments in the first study did not report the response process as any more difficult. Indeed, participants in study one generally reported the process of typing their responses easy, regardless of the length of the questionnaire. In study 2, there was no evidence of mode impacting on internal reliability, as would have been the case if the relatively inaccurate nature of typing on a smartphone rather than computer keyboard (Page, 2013) had begat typographic errors.

These results demonstrate that an instrument as long as sixty items in length can be administered by SMS, with comparable response rates, internal reliability, and factor structures to online administration. However, in instruments over ten items in length, mean responses tended to be higher, leading to lack of equivalence in terms of latent means and intercepts. Measurement invariance was strongest in the instruments with a single underlying factor. There is much that could be done to expand upon this preliminary investigation. The difference between instrument lengths used here were relatively coarse; the issues discussed here could be examined in much greater detail by systematically, repeatedly adding a single item to a questionnaire and examining cross-mode equivalence at each step. There also remains the question as to why SMS scores tend to be considerably higher than their online counterparts. These results tentatively suggest it is not age, instrument length (beyond ten items), distraction, or difficulty typing out the response – if this is supported by future research, additional explanations will be required.

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Short and sweet? Length and informative content of open-ended responses using SMS as a research mode

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Short Message Service (SMS) is one of the most widely used data services worldwide. This paper examines the assumption that the 160 character limit would force brief and thus comparatively uninformative responses in psychological research compared to other data collection modes. In laboratory classes, 463 psychology undergraduate students were randomly assigned to complete a two-item questionnaire by SMS, email, online survey, or paper survey. Two weeks later, participants completed a multiple-choice self-report risk taking questionnaire on paper. While SMS response lengths were statistically significantly shorter than those yielded in other modes, they did not contain less information.

One of the most widely used data services worldwide (Kuntsche & Robert, 2009), 36.3 billion Short Message Service (SMS) were sent in 2011 in Australia (ACMA, 2011). As mobile telephones are ubiquitous (Anhoj & Moldrup, 2009), and their SMS capabilities are used daily by the majority of people (Mackay & Weidlich, 2009), they provide unprecedented opportunities for researchers to communicate with participants wherever they may be, at any time of day (Haller, Sanci, Sawyer, Coffey, & Patton, 2006). SMS is an attractive option as commercial bulk text services make bidirectional SMS communication with large groups increasingly affordable (Steeh, Buskirk, & Callegaro, 2007). It is also pragmatically feasible as many of these services offer automatic response aggregation just as online survey services do, which avoids the cost and potential for error incumbent in data entry from modes such as paper responses (Johansen & Wedderkopp, 2010; Tomlinson et al., 2009). SMS constitutes an exciting opportunity for real-time, bidirectional communication between researchers and participants, however there is limited rigorous, methodical examination of its properties as a tool for psychological research (Cocco & Tuzzi, 2012; Tomlinson et al., 2009). Just as aspects of questionnaires other than their psychological content can impact on participant responses (e.g. question wording), the mode used in psychological research can impact on how participants engage with and respond to a questionnaire (Cocco & Tuzzi, 2012; Dillman, Smyth, & Christian, 2009; Kelly, 2002; Lynn & Kaminska, 2012). One important issue is whether SMS gathers less useful information than other modes. The character length restriction and cost of each SMS may limit the number of questions a researcher may ask, as well as length of responses. The two are inter-related because of the character limit of SMS, as more questions leave less room for responses to each question. In the interests of parsimony the current paper will focus on response length when the number of questions asked are fixed.

Open-ended questions do not have a pre-defined response set, such as yes / no or numbers in Likert-type scales, leaving the participant free to respond however they see fit. When constructing an open-ended question, the researcher should consider the length of response that they wish participants to give. This is related to pragmatic concerns, as shorter answers tend to be easier to categorise and can be more quickly analysed, while longer answers can provide more in-depth information by allowing participants more space to express their response. While there is some research regarding response length in the context of traditional data collection modes such as paper or online surveys (Kelly, Harper, & Landau, 2008), guidelines that apply to those modes do not necessarily translate well to SMS. In paper and online surveys, the amount of space afforded to the participant to answer the question can act as a subtle cue of researcher intent (Dillman et al., 2009). The amount of space allowed for responses is easily altered through adding carriage returns on paper surveys, and most online survey services offer at least rudimentary control over the size of text boxes intended for open-ended responses. However, no such control can be offered by SMS.

SMS sent in everyday life may be an indicator of what length may be expected from open-ended questions sent via SMS. Two often mentioned reasons for brevity in SMS are the character limit, and the social use of abbreviations (Doring, 2002). While it may be intuitively expected that the 160 character limit of SMS might foster brief responses, most mobile networks offer seamless stitching of multiple SMS into a single message (linked SMS) making this limit less salient to individuals sending SMS. Whether on an 'unlimited' or fixed credit plan, in everyday SMS usage, people do not keep track of the length of their SMS messages (Battestini, Setlur, & Sohn, 2010), suggesting they do not actively attempt to minimise conversations to fit in a single text. Frehner and Lang (2008) found every day, unlinked SMS communication was under the 160 character limit, with an average of approximately 20 words, or 97 characters. Linked SMS, however, were longer, containing an average of approximately 50 words, or 280 characters. The longest linked SMS in the corpus was 94 words, or 485 characters. It should be noted that 485 characters is not neatly divisible by 160, indeed only six characters less would have made the linked message the equivalence in cost to three individual messages, rather than four. This suggests that people may not be paying attention to the character limits of their messages to minimise costs. To place these message lengths in context, email messages within the same corpus were an average of 131 words, containing up to 1192 characters.

Cocco and Tuzzi (2012) proposed that of SMS and face-to-face interview data are similar as SMS engenders a 'virtual presence' of the researcher, resulting in interview and SMS data involving a similar social, synchronous, bidirectional element to communication between the researcher and participant, which is lacking in other research modes such as online or paper surveys. Indeed, the main reason for sending an SMS is for social contact (Battestini et al., 2010; Polite, 2001). In a general social usage it is not the content of the message, but the gesture of sending the message that is important (Frehner & Lang, 2008). In these contexts, the message content tends to be more conversational and thus less structured and briefer (Cocco & Tuzzi, 2012), but are not necessarily less informative. This, coupled with the greater difficulty of typing SMS than typing at a computer, fosters the frequent sending of short SMS, which may often consist of single words. A word is defined in the current study as any string separated by spaces, which includes isolated numerals as words, and the substitution of numbers for words. This substitution is expected in SMS communication, as writing numeric values as numbers uses fewer characters than spelling them out, i.e. "21" in comparison to "twenty one", shortening the overall length of the message. Given the proliferation of this abbreviated text speak (Power, Power, & Horstmanshof, 2007), it may be expected that responses to open ended questions given via SMS will contain significantly shorter words than other modes, having the effect of shortening the length of a message in terms of characters, but not in terms of the number of words used. Alternately, if text speak abbreviation is not used, the converse may be true. The Menzerath-Altmann law, a general principle of the structure of language, states that the longer a language construct, for example a sentence, the shorter its constituents, for example words within a sentence (Altmann, Grzybek, Naumann & Vulanovic, 2012). This would lead to the expectation that the overall shortness of an SMS should be associated with the usage of significantly longer words than other modes. Empirical evidence specific to the context of SMS used as a tool to collect research data will help to clarify which of these expectations would be met in an applied research setting.

The question remains whether a shorter response in terms of characters would necessarily be associated with less informative contents. If response lengths across modes are vastly different, it is reasonable to assume the longer responses will contain more useful information. If response lengths are similar, however, the difference in informational content may be more subtle. There is some evidence that amount of information contained in a language construct can depend on its mode of production, once the response length is controlled for. For example, oral narratives tend to be longer but contain less information than written narratives (Ravid & Berman, 2006).

Basic expectations of how much information a mode can provide are vital to informing research design in general. These issues are particularly important for a mode with inherent limitations, such as SMS. As the possibilities of SMS as a tool for data collection become apparent, and researcher interest is increasing due to its ubiquity and convenience, this is an opportune time to explore the mode's properties. The aim of this study was to ascertain the comparative response length and informative content within a single measure open-ended SMS question in the context of other modes used for psychological research. Specifically, it explored the impact of mode on open-ended response length (operationalized as number of words, average length of words, and number of characters in total) and amount of information presented within that response (operationalised as the number of points raised by participants, and the difference between height and risk-taking information given using different modes and information given at follow-up). While it expected that character limit considerations of SMS that will produce the shortest answers, it is not clear whether SMS responses will contain less information than other modes.

Method

Four hundred and sixty three psychology students (228 female, 151 male, 84 unspecified gender) aged 16 - 55 (M=20) answered two questionnaires during laboratory classes. An undergraduate sample was used for two primary reasons. Firstly, and most importantly, undergraduate students are one of the largest participant pools used in non-clinical psychological research (Wintre, North, &

Sugar, 2001). It is therefore logical evaluations of a research mode should focus on this particular sample group.

Secondly, this allowed for the context of participation to be held consistent across all participants, regardless of conditions. Given the importance of considering context when comparing mode-based response properties (Lynn & Kaminska, 2012), all participants completed the measures in the same room, during their introductory psychology course weekly tutorials. Because the focus of the current study is the effect of the mode, rather than the role of distraction, it was important to control for environmental variables that may differ between modes, as individuals participating via SMS in a naturalistic setting are more likely to be in public places, and thus have a more disrupted engagement with the questionnaire. Factors likely to impact on social desirability such as the presence of the researcher (Wilkerson & Martin, 2002), the task introduction and instructions were kept constant across groups, and responses were rendered anonymous by matching across questionnaires using a unique ID code drawn from personally relevant, invariant questions (e.g. the second letter of their first name).

At time 1, participants were randomly assigned to complete the first questionnaire by SMS, email, online survey, or paper survey. To ensure all four modes conditions received the questionnaire at the same time, participants in the SMS and email condition provided their email addresses or telephone numbers, with the instructions not to check for incoming messages until the tutorial group was relocated to a computer laboratory. Regardless of mode response, all participants were moved to the same computer laboratory. Email questionnaires consisted of plain text emails sent from a custom-registered email account, to be checked on provided computers. SMS used the same questionnaire sent via a commercial web-based SMS scheduling and aggregation service, to be checked on the participant's own mobile telephone. Participants in these conditions were asked to enter and submit their responses by replying to these messages. Participants in the online condition were provided with a short URL leading to the survey. Though both online and email responses were completed online, they differed in visual environment; the single large text area of email as opposed to separate text boxes for each question in the online survey. Those in the paper condition were provided with a printed version of the questionnaire on a single A4 page. Because the amount of space provided for responses can impact on response length (Dillman et al., 2009), the spaces available for the open-ended response were matched across online and paper questionnaires, though similar matching was not possible for SMS or email questionnaires.

To mirror a real-life research context, the current study explored the length of responses to open-ended questions in the context of a larger questionnaire, flanked by Likert-type or single-word questions. The topic of risk taking behaviour was chosen as the content for the current study, as it is likely to be present, in varying levels, in the current sample of young adults. The current study focused only on response length as a function of mode, rather than as a function of number of questions asked. Because of this, the number of questions asked was fixed. The questionnaire consisted of five closed questions requiring short answers, and one open-ended question; (1) participant ID code (2) gender (3) age, (4) estimated height (5) the open-ended question. The questionnaire remained short to allow participants scope to provide a long answer to the open-ended question. SMS behaviour in everyday settings, as explored by Frehner and Lang (2008) was used as a guide for what might be a realistic response length via SMS. The open-ended question was formulated so that it may be reasonably answered in 280 characters or less, and wording was used to avoid participants producing closed yes/no answers. It was as follows:

> *Taking a risk can include many things, such as playing dangerous sports, having a poor diet, quitting a job without another to go to, gambling, driving too quickly, or challenging a friend's opinion. Thinking about the past month, what risks have you taken?*

At time 2, two weeks later, all participants had their height measured by the researcher, and completed a second questionnaire on paper. Paper was chosen as the comparison mode due to its long history of use in psychological research (Dillman et al., 2009). This questionnaire included a multiple choice portion, to be used as a final check of the open-ended response contents (similarly to Allison, Okun & Dutridge, 2002). Using a multiple choice, rather than open-ended question at this time was to allow a standardised comparison in risk-taking behaviours across participants. Providing a list of risk taking behaviours the participant group was most likely to have engaged in was intended to assist recall of risks participants may otherwise not have thought of, and thus omitted from their open-ended response. Drawn from Nicholson's Risk Taking Index (Nicholson, 2005), and the 2013 State and Local Youth Risk Behaviour Survey (CDC, 2013), with items likely to be most relevant to the current undergraduate sample, as follows:

Taking a risk can include many things. Thinking about the past month, put a tick next to the risky things you have done.

- □ *Not wearing a seat belt (when driving, or a passenger)*
- □ *Riding in a car driven by someone who had been drinking alcohol*
- □ *Texting or e-mailing while driving a car*
- □ *Carrying a weapon such as a gun, knife, or club*
- □ *Being part of a physical fight*
- □ *Having sexual intercourse without using a condom*
- □ *Having sexual intercourse with multiple partners within a month*
- □ *Taken illegal drugs (including Marijuana, ecstasy, heroin or amphetamines)*

doctor's prescription

- □ *Taken a prescription drug (such as Adderall, Ritalin, or Xanax) without a*
- □ *Rock-climbing*
- □ *Scuba diving*
- □ *Fast driving*
- □ *City cycling without a helmet*
- □ *Standing for election*
- □ *Publicly challenging a rule or decision*
- □ *Smoking*
- □ *Poor diet*
- □ *High alcohol consumption*
- □ *Quitting a job without another to go*
- □ *Gambling*
- □ *Risky investments*

Analysis and Results

At time 1, 80 participants answered via email, 109 via online survey, 119 via paper, and 87 via SMS. Responses were first compared in terms of word length, formality and diversity of words used, and then their informational content (correspondence between information contained in open-ended responses, factual information, and subsequent self-report on the same topic).

Data Preparation

Prior to analysis, all variables of interest were screened for outliers (datapoints exceeding the third quartile), normality, and homogeneity of variance. There were no graphic symbols or emoticons present in responses. Though all four hundred and sixty three students participated in the activity, substantially fewer provided data due to absences, illegible or lost responses, and decisions not to consent to having their data used for subsequent analysis. In total, 395 participants completed the open-ended response at time 1, and 304 completed the questionnaires at both time 1 and 2. Analyses were conducted with and without outliers omitted, and with and without controlling for demographic variables of age and gender. Because conclusions were not affected they were included in final analyses.

Significant positive skewness was revealed in all variables of interest by Shapiro-Wilk and D'Agostino tests, and was corrected for by iteratively raising data to a power of .001 increments until skewness was no longer significant. Once variables were transformed to correct for skewness, screening for homoscedasticity using the Fligner-Killeen test of Homogeneity of Variances revealed non-significant heteroscadicity in all variables of interest, indicating suitability of these data for ANOVA. To check that the transformation did not distort conclusions, non-parametric Kruskal-Wallis rank sum tests were carried out with the same variables as the ANOVA, using the untransformed data. These results are not reported, as they were closely in line with results from ANOVA performed on the transformed data.

Response length

Response length in characters, words, and average word length were calculated from open-ended responses at time 1. The shape of response length distribution within each mode may prove an informative measure of the length of responses that may be expected from each mode. Given the significant positive skewness found across modes, comparison of standard deviations would be insufficient to capture the dispersion of response lengths. Rather than visualise the distribution of each mode traditionally, violin plots were generated to allow clearer comparison of the distribution shape across the entirety of the distribution, including the thinner tails of the distribution (figure 1). Length of response in characters on the y axis, and the distribution shape mirrored on the x axis. Note that the positive skew of response length is shown as a bulge toward the bottom of each distribution. For clarity of comparison, the median response length for each mode is displayed on each distribution at the appropriate position on the y axis. A K-sample Anderson-Darling Test (Scholz & Stephens, 1987) was used to test whether the distributions of response length in SMS, paper, online and email data came from the same underlying distribution. The test was significant (unadjusted for ties t=4.086, p=0.003), indicating that the distribution of response length (in characters) was significantly different across modes. As can be seen in figure 1, SMS responses were significantly more concentrated around short response lengths than the other modes, a pattern echoed to a lesser degree by email responses.

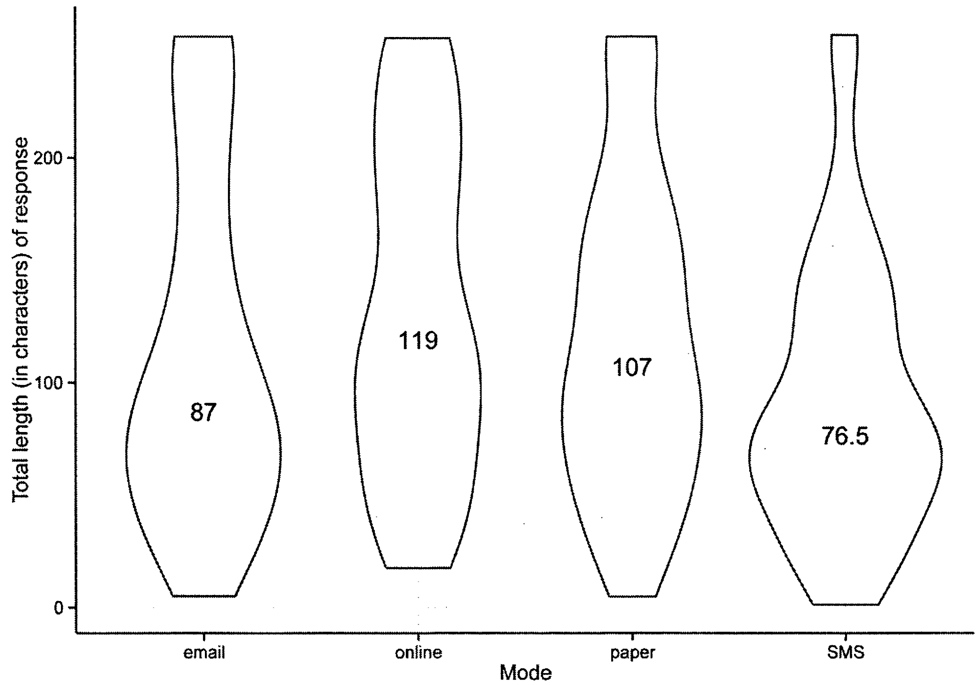


Figure 1: Distribution shape of response lengths, by mode

Note. The positive skew of response length is shown as a bulge toward the bottom of each distribution. For clarity of comparison, the median response length for each mode is displayed on each distribution at the appropriate position on the y axis.

One-way between subjects ANOVA were conducted to compare the effect of measurement mode (online, email, SMS or paper) on the total length of responses (in characters) at time 1. As expected, the effect of mode on number of characters used was small and significant, though the effect size was very small $F(3,381) = 4.91$, p=.002, partial η^2=0.04. Comparing across modes, SMS had the fewest characters, followed by email, and paper, while online had the most characters (table 1). Mode was responsible for 4% of the variance in the number of characters used in responses. Post-hoc comparison by way of Tukey's HSD indicated that SMS responses were significantly shorter than online (p=.001) and paper (p=.031) responses.

Table 1. *Response lengths at time 1*

	Email	Online	Paper	SMS
Average number of characters	113.68	130.84	120.06	91.95
Average number of words	18.42	23.13	21.14	14.8
Average length of words (in characters)	5.36	4.96	4.94	5.24
Count of simplifications and substitutions	5	8	7	5
Count of reductions	8	7	15	5
Count of spelling errors	8	2	2	2
Count of typographical errors	1	5	6	0
Average token-type ratio	0.94	0.92	0.93	.095
Average Yule's K	60.71	83	77.71	56.71

Note. This summary is drawn from all responses at time 1, n = 385.

The effect of mode on the average length of words used in responses was small and significant, $F(3,381) = 3.4$, p=.018, partial η^2=0.03. Comparing across modes, email had the longest words on average, followed by SMS, online surveys, and paper. Results supported the Menzareth-Altmann law's assertion that longer language constructs are associated with shorter constituent elements, as the modes with the longest open-ended responses (paper and online) had shorter words on average. The smallness of the effect makes sense given that word lengths and text lengths were quite similar (Grzybek, Stadlober, & Emmerich, 2007). Mode was responsible for 3% of the variance in the length of words used in responses. Post-hoc comparison by way of Tukey's HSD indicated that paper responses had significantly shorter words than email responses (p=0.04).

The effect of mode on the average number of words used in responses was pragmatically small (on the order of five words), but significant, $F(3,381) = 7.46$, $p<.001$, partial $\eta^2=0.06$. Comparing across modes, SMS had the fewest words, followed by email, and paper, while online had the most words (table 1). Mode was responsible for 6% of the variance in the number of words used in responses. As with the effect of mode on number of characters used, Post-hoc comparison by way of Tukey's HSD indicated that SMS responses had significantly fewer words than online ($p<.001$) and paper ($p=.003$) responses. Taken together, these results suggest that SMS responses were shorter overall due to the use of fewer words than other modes, rather than the use of shorter words.

Formality and diversity of words used

Two independent coders categorised spelling modifications in open-ended responses, following Combes, Volckaert-Legrier & Largy (2012)'s typology; occurrences of substitutions and simplifications (i.e. 'I'll' instead of 'I will', but not possessives like 'friend's'), reductions (i.e. 'mess' rather than 'message'), spelling errors (i.e. 'nessecarry' rather than 'necessary'), and typos (i.e. 'hjt' rather than 'hit'), see table 1. Chi-square contingency tables were revealed that there was no significant differences between modes in the presence of substitutions and simplifications, spelling errors, or typos ($\chi^2(3)=4.79, p=0.95$; $\chi^2(3)=3.44, p=0.32$; $\chi^2(3)=0.2, p=0.97$ and $\chi^2(3)=6.15, p=0.104$ respectively).

The textual content of the open-ended responses can also be thought of in terms of the variety in the vocabulary used. The more frequently the same words are used, the more limited the vocabulary (Köhler, Altmann & Piotrowski, 2005). This can be measured in terms of the vocabulary size, the number of unique words used in a response, or the token-type ratio, which is the weighted range of vocabulary for number of words in the text being analysed. However, the token-type ratio is highly dependent on the length of text, and given the shortness of responses in the current study (averaging less than 150 characters) is therefore a potentially flawed measure of lexical richness (Tweedie & Baayen, 1998; Popescu, 2009). We will therefore also examine the text in terms of Yule's K, which is a length-independent measure of the diversity of the vocabulary (Miranda-Garcia & Calle-Martin, 2006).

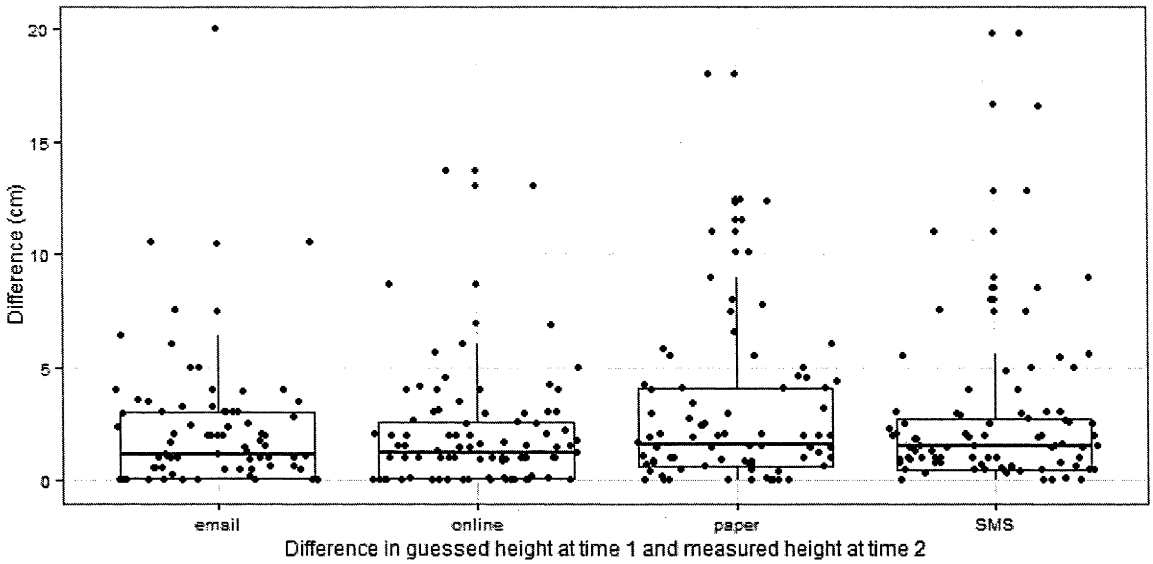
Both the token-type ratio and Yule's K were calculated for each open-ended response. As can be seen in Table 1, both statistics were similar across modes. ANOVA confirmed a lack of significant difference each of these statistics; neither token-type ratio nor Yule's K significantly differed by mode ($F(3,216)= 1.637$, $p=.182$, partial $\eta^2=.02$ and $F(3,216)= 1.018$, $p=.385$, partial $\eta^2=.014$ respectively). This suggests that mode did not impact specifically on the diversity of the vocabulary used.

Informational Content

The effect of mode on the accuracy of responses as measured by the difference between reported height at time 1, and measured height at time 2 was not significant, $F(3,358)= 0.274$, $p=.844$, partial $\eta^2=0.02$, indicating that mode did not impact on response validity as operationalised as correctness of self-reported height.

Descriptively, participants reported an average of approximately three risks reported in open-ended responses overall. This did not significantly differ by mode, $F(3,381)=.571$, $p=.634$, partial $\eta^2=0.03$, with participants responding by paper having an average of 3.4 risks, by email 3.3 risks, online 3.2 risks, and by SMS 3 risks. This suggests that mode did not have an impact on the amount of informative content within responses.

The absolute difference between number of risks mentioned at time 1, and number of risks reported at time 2, and the number of risks reported in the 'other' category at time 1 were used as a measure of the comprehensiveness of open-ended responses. Comparison in self-reported number of risks across time points is only to be interpreted as a broad check of consistency between self-reported risk at time 1, and risks selected at time 2. The two measures may not directly correspond due to participants engaging in risky behaviours between measures, or because the multiple choice list at time 2 acted as a reminder of risks forgotten at time 1. Additionally, they do not provide an absolute measure of how similar the two sets of risks are. However, this comparison is meaningful in that it helps to disentangle whether few risks reported at time 1 are due to a genuine lack of risk taking, or a poor response. There was no significant difference in the number of 'other' risks identified by participants at time 1, $F(3,319)=.297$, $p=.83$, indicating that random assignment across modes was successful, and that subsequent analyses were truly disentangling mode effects from individual differences in risk taking.



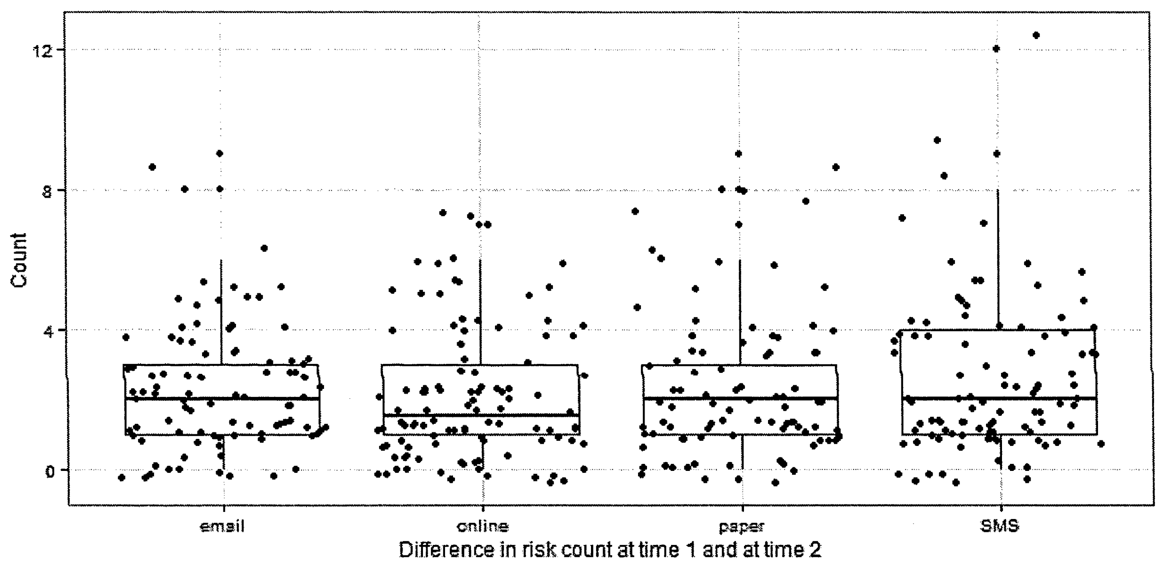


Figure 2: Differences in guessed and actual height (above) and count of self-reported risk-taking behaviours (below), split by mode. The points have been jittered on the horizontal axis to avoid overplotting, thus giving a more readable view of the distribution of points on the vertical axis.

Note. The vertical axis of the upper plot has been truncated at 20cm for readability. There are 4 outliers in email condition, and 4 in online conditions extending up to 70cm.

Though the number of risky behaviours reported in the open-ended question categorised as 'other' indicate that the specific risks used in the questionnaire at time 2 were not a comprehensive reflection of the risks taken by the current sample, there was not a significant effect of mode on the difference between number of self-reported risks reported at time 1 and time 2, $F(3,379)=1.82$, $p=.124$. This indicates that random assignment across modes was successful in ensuring a relatively even distribution of low and high risk takers responding in each mode, supporting the assertion that mode did not affect the amount of informative content within responses.

Discussion

Results consistently demonstrated that the responses to an open-ended question embedded in a larger questionnaire is statistically, but not pragmatically, impacted upon by mode. In line with previous research (e.g. Cocco & Tuzzi, 2012) SMS responses were significantly shorter in total length, having fewer characters and fewer words than other modes. However, SMS here did not contain more incorrect information, or fewer points of information, than other modes. At an average of ninety two characters, SMS response lengths to the open-ended question were marginally shorter than the average SMS length reported in Frehner and Lang (2008)'s corpus. This makes sense, as the corpus looked at the total length of SMS, while the current study looked only at the length of the open-ended question, a portion of the total SMS response.

In accordance with the Menzareth-Altmann law, the shorter overall total length in terms of characters of SMS responses was reflected in longer average word lengths than the other three modes. Both online and paper responses had the opposite tendency of longer responses overall, but shorter constituent words. It is unlikely that the 160 character limit of SMS is driving this use of fewer words, as all four modes had an average response length of less than 160 characters. As SMS responses did not contain significantly more substitutions or reductions than the other modes, neither is it due to the use of numeric phonological substitution discussed in Power et al. (2007). Given that mode did not impact on the token-type ratio, it does not appear that SMS has fewer words due to less redundancy.

Though responses were longer than those yielded by SMS, the pattern of response lengths in terms of characters, number of words, and word length for email was far more similar to SMS than online or paper responses. Considering the shape of the distribution of response length in characters, SMS and email had a similar shape of clearly positively skewed distributions bulging about median responses, though the bulge was more extreme for SMS, while paper and online responses had far more diffuse, almost bimodal response length distributions. Cocco and Tuzzi (2012)'s allusion to SMS engendering 'virtual presence' of the researcher may be considered and applied here, as the similarity of SMS and email responses in the current study may be due to the social aspect of use of those modes of communication. SMS and email may be conceptually grouped as modes typically used for bidirectional social communication, while paper and online responses are unidirectional modes generally not encountered in social circumstances. SMS and email may share the social rather than informational motive for use, where the fact the message was sent is more important than its content (Frehner & Lang, 2008), and the message content tends to be briefer (Cocco & Tuzzi, 2012), even if informal language such as text speak was not used. The lack of text speak in SMS responses in the current study may be an artefact of the formality of responding in a teaching laboratory context, or may reflect the decline in text speak usage as smartphones make it easier to type full words due to qwerty keyboards and auto-correct.

As the first step in examining the impact of SMS as a data collection mode on response length and informational content, this study made a number of somewhat arbitrary choices. Firstly, the operationalization of informational content was not ideal. Using a directly observable phenomenon in parallel with a less visible psychological construct (risk taking) was valid, but the choice of height was problematically easy, reflected in the very small effect size revealed in analyses. Similarly, attempting to corroborate robustness of an open-ended question with a more standardised question format is valid. However, the correspondence between an open-ended question, and later multiple-choice question is not ideal. There are individual differences in response behaviour to particular question types, for example culturally-based polarisation in Likert responses (Heine, Lehman, Peng & Greenholtz, 2002). Further, the time between measures may have allowed more risk taking to occur. Given the random assignment of participants to different mode response conditions, it is likely that these problems would have added noise to the data rather than systematically bias conclusions. This noise may have contributed to mode explaining only a small amount of variance in response length. Additional unmeasured variables that impact on verbosity, such as personality traits (Mairesse, Walker, Mehl & Moore, 2007), or verbal fluency (Gold & Arbuckle, 1995), may have added further noise to the data.

The choice to conduct the current study in a teaching laboratory context is both a strength and a weakness. Environmental effects such as being in a hurry when receiving SMS, having to search for an email in an overfull inbox, having to configure a browser to correctly load an online survey, and having to find a lost paper survey were controlled for by having all participants complete the questionnaire in a standardized environment and timeframe. This yielded a clearer comparison of the impact of mode alone on response length and informative content, in particular controlling for time pressure, but removes opportunity to examine whether time pressure, the formality of the response situation, or other environmental factors may further modify the response length to research conducted via SMS in a real-world research setting. A related concern is that participants in the email condition were constrained to responding using computers, whereas in everyday life they may respond to emails using their smartphones. This highlights the importance of considering the amount of space provided for answers by response mode, as the ability to use smart phones to respond to both emails and SMS may make the two modes more similar in a real-world setting than they were in the current study. This limits the ability to draw clear conclusions about email as a mode.

Acquiescence, resulting in demand effects, is important to consider when exploring the impact of mode on response properties (Kelly et al., 2008). Participants were aware from the outset that the focus of the researcher was the usefulness of SMS as a tool for research, and that across modes their responses would be screened for a number of indicators of response quality. Though response length and amount of information conveyed was not explicitly mentioned, participants may have provided longer or more detailed responses due to perceived demand characteristics than they otherwise would have offered, particularly in the SMS condition given the focus of the researcher.

Because the focus was on cross-modal comparison, this study explored response length with a relatively arbitrary set of five questions. Doing so limits generalizability, but opens avenues for further investigation seeking to focus specifically on SMS. In terms of the SMS character limit, there was scope for the researcher to send more questions. The relatively short responses demonstrated scope for participants to provide more answers. Pragmatically speaking, the more questions there are, the less space there is for participants to respond to each. The nature of questions also come into play, as more complex questions require more complex explanations (thus limiting how many the researcher may send), and more detailed answers (thus limiting how long responses will be). It is therefore likely that a different number of questions, or different configuration of question types (i.e. Changing a Likert-style response to an open-ended question) may impact on response lengths overall. Future research could vary the number of questions to uncover the impact of question complexity on response length, and also whether more questions lead to longer responses overall, or truncated answers to each question. It could also somewhat overcome the limitations of the current study by choosing an observable metric other than participant height, and using a single instrument multiple times, rather than two different measures of the same construct as was done in the current study.

This paper applied both non-parametric statistics and transformation with parametric statistics to deal with the zero-bounded highly skewed variables, and it should be noted that p values were very clearly non-significant. However, it remains that the conclusions reached are largely based on 'proving the null', in a context of very small effect sizes. Future researchers should certainly employ statistics better suited an expectation of null hypothesis confirmation, such as taking a Bayesian approach.

This study compared response length and informative content for an open-ended SMS question to other modes of data collection used for psychological research. SMS response lengths were statistically significantly shorter than those yielded in other modes, but SMS responses did not contain less valid information, or less information overall. This suggests that, for a question requiring only a short response, SMS is comparable to other modes as a viable mode for research involving open-ended responses embedded in a questionnaire.

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Chapter 5: How does SMS compare with other tools for data collection?

In chapters 2 and 3, we saw that SMS has the capacity to be a useful tool for self-report psychological research. Chapter 4 began to explore that capacity, and found that SMS can indeed be used to collect self-report data, providing acceptable response behaviour, and with some caveats, reasonable psychometric validity. Yet, capacity alone is insufficient if a researcher is considering whether or not to use SMS for their study. The current research landscape has a multitude of data collection tools available (Dillman, Smyth, & Christian, 2009). There may be other equally viable, or better, alternatives to SMS. This final chapter examines how SMS performs in comparison to other tools used to collect self-report data.

Like SMS, software applications (apps) running on mobile telephones are also gaining traction as a data collection tool (e.g. Holloway et al., 2014; Rosser & Eccleston, 2011). The first paper, *Is SMS APPropriate? Comparative properties of SMS and apps for repeated measures data collection*, investigates how the two modes compare when all other aspects of the study design are held constant. The second paper, *SMS = Send My Survey: Short Message Service for Longitudinal Research*, takes a similar approach, but compares SMS against paper and email surveys, and digital devices.

The final paper, *Applying cross-language principles to cross-mode measurement invariances*, examines how SMS compares to online surveys specifically in terms of psychometric validity. This paper draws from the robust literature investigating what degree of difference is acceptable between different language versions of the same instrument, and applies it to the degree of difference found between SMS and online administrations of that instrument.

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Is SMS APPropriate? Comparative properties of SMS and apps for repeated measures data collection

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The ubiquity of mobile telephones worldwide offers a unique opportunity for bidirectional communication between researchers and participants. There are two ways mobile phones could be used to collect self-report data: via Short Message Service (SMS), or app (mobile telephone software applications). This study examined the comparative data quality offered by SMS and app, when mobile phone type, self-report instrument, and sampling schedule are controlled. One hundred and ten undergraduate students used their own iPhones to complete the same repeated measures instrument on twenty occasions, responding either by SMS or app. There were no differences between SMS and app respondents in terms of response rates, or response delay. However, data from those responding via SMS was significantly less complete than from app respondents. App respondents rated their respondent experience as more convenient than SMS respondents. Though findings are only generalizable to an undergraduate sample, this suggests that researchers should consider using apps rather than SMS for repeated measures self-report data collection.

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Over three quarters of the global population own a mobile telephone (The World Bank, 2012). As either a supplement or replacement to traditional research modes such as telephone or postal surveys, mobile telephones offer an unprecedented opportunity for researchers to communicate with participants in self-report research. Though uptake of mobile technology in self-report research is gaining momentum, there remains little structured investigation into the optimal way to use mobile phones in self-report research (Haller, Sanci, Sawyer, Coffey, & Patton, 2006a). Two of the ways mobile telephones can support self-report data collection are Short Message Service (SMS), and mobile telephone applications (apps).

SMS is a text-only messaging system available on even the most basic mobile telephone handset, and a very common communication method in people's daily lives (ACMA, 2013; Anhoj & Moldrup, 2009; Mackay & Weidlich, 2009). Its widespread nature may provide an important opportunity for researchers to communicate with their participants (Haller, Sanci, Sawyer, Coffey, & Patton, 2006b; Lehman, 2011). Some research using SMS involves sending messages through a mobile handset, but a more common approach is to manage scheduling, sending and receiving of SMS through online databases. Some do this through pre-existing SMS aggregation services (as in Walsh and Brinker, 2012), and others write a computer program of their own to manage the SMS (as in Reimers and Stewart, 2009).

Apps are downloadable software programs that are common to all smart phones (Miller, 2012). They are typically tied to a particular mobile operating system, such as Android or iOS, though there has been a move toward cross-system app compatibility (Ribeiro & da Silva, 2012). There are millions of apps used for different purposes, from communication to games, and many are designed specifically for self-report data collection. With over a thousand self-report survey apps and at least six thousand different health-related apps, use of apps for health and medical research and intervention is gaining traction (Rosser & Eccleston, 2011). Self-report apps can be designed to mimic the web browsing experience (and thus involve a user experience similar to online surveys), or can have their own aesthetic more in line with mobile telephone interfaces (Kojo, Heiskala, & Virtanen, 2014). Researchers using apps may choose to use pre-existing software, such as iSurvey, or design their own apps to meet their specific research goals (e.g. Fukuoka & Kamitani, 2011; and Morris et al., 2010).

Recognising the global saturation of mobile phones, and the potential use of both apps and SMS as platforms for self-report data collection, it is important to establish how SMS and app compare as a data collection method. Complete and timely responses are important for building a high quality dataset, and so response completeness and response delay are a useful metric for comparing how SMS and app perform as data collection tools. Two sources of data incompleteness are complete non-responses, and item skipping resulting in an only partially complete instrument (Sax, Gilmartin, & Bryant, 2003). Non-responses threaten the total sample size available for analyses (Fox, Crask, & Kim, 1988) and can lead to an unrepresentative portion of a given population being sampled, threatening the validity of research (Flick, 1988). Skipping items can result in small levels of incompleteness. This is problematic because score totals cannot be calculated (Mogensen, 1963), and item missingness causes difficulties for many methods of statistical analysis (van Buuren, 2010).

Meta analyses suggest that the average response rate in academic research is roughly fifty percent (Baruch & Holtom, 2008). This can depend on the specific mode used for data collection, with comparative studies indicating mail surveys obtain a higher response rate than voice calls (Dillman et al., 2009), and online surveys a higher response rate than mail surveys (Cook, Heath, & Thompson, 2000). A comparison of participants responding via app and via paper diary has found a higher response rate in app respondents (Tsai et al., 2007).

Repeated measures research using apps has reported roughly eighty percent response rates (Fukuoka & Kamitani, 2011), suggesting that a relatively high response rate may be expected from apps. Many apps follow the lead of online surveys by prompting participants to complete skipped items, and only allowing them to submit their response when every item in the survey has been satisfactorily completed. For online data collection, some studies have found this has led to significantly less item skipping in online surveys in comparison to paper surveys where no such prompts are possible (Vijver & Harsveldt, 1994), though others have found the opposite (Richardson & Johnson, 2009).

Response rates to research using SMS to communicate with participants vary from twenty percent (Chib, Wilkin, Ling, Hoefman, & Van Biejma, 2012) to one hundred percent (Donaldson, Fallows, & Morris, 2014). SMS has no provision for automatically detecting and prompting participants to complete skipped items in a larger questionnaire, so provides no barrier to incomplete submission. In a comparison of completeness of SMS, paper and online diaries, Lim, Sacks-Davis, Aitken, Hocking, and Hellard (2010) found that participants responding via SMS were more likely to return diaries, but provided more incomplete data, than those responding using paper or online diaries. Together, this literature suggests that data collected via SMS may offer higher response rates, but lower response completeness, than data collected via app.

As the time between an event or experience increases, so does the likelihood of recall bias distorting self-report (Raphael, 1987). Minimising the delay between when a response is required, and provision of that response would likely improve the accuracy of the data. Mode can impact on both how quickly people begin their response, and how long it takes to complete it. For example, web surveys are quicker to complete than paper surveys with the same content (Richardson & Johnson, 2009). Participants tend to respond more promptly when using SMS, in comparison to paper (Asiimwe et al., 2011; Broderick et al., 2012). Response delays in SMS research range from two minutes (Conner & Reid, 2012) up to an hour (Lepper, Eijkemans, Beijma, Loggers, & Tuijn, 2013). Response delays in app research have been around eight minutes (Hofmann & Patel, 2014). Although range and median are informative for forming response delay expectations, they have limited usefulness for direct comparison of the response delays that may be expected when collecting self-report data via SMS and app. To date, no research has directly compared the response delays associated with SMS and app self-report responses.

The way participants perceive a particular research mode can impact upon how they engage with it (Dillman, et al., 2009). Positive perceptions of convenience can lessen the perceived burden of responding (Sharp & Frankel, 1983), and lead to deeper engagement with research, and thus more honest and thoughtful responses (Naughton, Jamison, & Sutton, 2013). Negative perceptions regarding data privacy can be a barrier to using mobile phones for research purposes (Déglise, Suggs, & Odermatt, 2012; Ranney et al., 2014). Reflecting on their participation experience, across a number of studies participants have reported that they felt responding via SMS (Akamatsu, Mayer, & Farrelly, 2006a; Broaddus & Dickson-Gomez, 2013; Lim et al., 2010; Matthews, Doherty, Sharry, & Fitzpatrick, 2008) and app (Fernandez, Johnson, & Rodebaugh, 2013; Marshall, Medvedev, & Antonov, 2008) were convenient and private. To date, there has been no research directly contrasting perceived privacy and convenience of SMS and apps being used for self-report research.

The aim of the current paper is to directly contrast SMS and app in terms of response rate, response completeness, response delay, and participant evaluation of privacy and convenience. Findings will be used to discuss the potentially different utility of apps and SMS for researchers.

Method

Participants

To standardize the response platform, this study was only open to individuals who owned an iPhone One hundred and ten undergraduate students in Australia participated in return for course credit. Aged 17-55 (*M*=22), 58% of participants were female.

Materials

All participants completed a computer administered questionnaire consisting of demographic and mobile ownership questions. This was followed by a short instrument on the topic of mental time travel (the temporal orientation of current thoughts) completed via the participant's mobile phone. The instrument consisted of six questions requiring a numeric or short open-ended response, with all questions but the sixth being mandatory. Participants responding via app did so via *iSurvey*, those responding via SMS replied using their own phone plans. Upon exit, participants completed a second computer administered questionnaire regarding their participation experience. This consisted of rating the privacy and convenience of their response experience on a three-point scale of poor, neutral, or good.

Procedure

Participation began with a physical meeting with the researcher to complete the first computer administered questionnaire, and to have the protocol explained to them. Because the end user experience can be markedly different even with very similar mobile phones due to different screen sizes, and user interface layouts (Keijzers, Ouden, & Lu, 2008), all participants in the current study responded via iPhone. Those responding via app were guided through the app installation process. The app had the six questions pre-loaded. Those responding via SMS had the six items sent to them via SMS within 30 minutes of the meeting. A test SMS prompt was sent during this meeting to confirm the researcher had the appropriate contact details, and a test run of the six item questionnaire was completed to ensure the task was clear and the mobile systems were functioning correctly.

Due to a limited licensing timeframe associated with the survey app, data collection began with all participants responding via app, then proceeded to use only SMS once that phase of data collection was complete. To minimise the potential for this non-random assignment to bias participant behaviour, participants were not aware upon sign-up whether they would be responding via app or SMS. In the two days following the physical meeting with the researcher, all participants received a total of twenty prompts (ten per day) to complete the short questionnaire. The prompts were sent via SMS to both SMS respondents (who responded by replying to the prompt SMS with their answers) and the app respondents (who responded via *iSurvey*). Upon completion, participants attended a follow-up appointment to complete the second computer administered questionnaire. When required, those who spent money on the SMS aspect of participation were reimburse

Results

SMS and app responses were compared in terms of response completeness and response delay. A *partially* complete response consisted of an attempt of at least one question, a *basically* complete response was an attempt of the five required questions, and a *fully* complete response an attempt of all six questions (where the sixth was specified as optional). To explore whether responses were being provided according to prompts, or participant's own schedule, responses were coded as *extraneous* if their preceding prompt had already received a response.

Descriptively, app respondents provided more full (60% versus 38%) and basic (74% versus 35%) responses than SMS respondents, though partial responses were equivalent across the two groups (74%). A logistic multilevel model was fit, with mode as a predictor of receipt of a full response, which was nested by participant at level 1. A significant level 2 random intercept (*b*(SD)=2.68, 95% CI [2.59, 3.55]) indicated this nesting was meaningful for this comparison. The level 1 model coefficient indicated that there was a significant difference in full response rate between those using an app, and those using SMS, *b*=-2.69, 95% CI [-4.25, -1.98]. The exponent of this corresponds to an odds ratio of 0.067, which can be interpreted as stating that participants using SMS were much less likely to provide a full response than those using an app.

A logistic multilevel model was fit, with mode as a predictor of receipt of a partial response, which was nested by participant at level 1. Both the level 2 random intercept (*b*(SD)=2.824, 95% CI [2.72, 3.83]), and level 1 model coefficient (*b*=-3.42, 95% CI [-5.21, -2.74]) were significant. The model provided an odds ratio of 0.03, that is participants using SMS were significantly but slightly less likely to provide a basic response than those using an app.

A logistic multilevel model was fit, with mode as a predictor of receipt of a partial response, which was nested by participant at level 1. The level 2 random intercept (*b*(SD)=1.90, 95% CI [1.76, 2.69]) was significant, but the level 1 model coefficient indicated that there was not a significant difference between scheduling occasions, *b*=-0.25, 95% CI [-0.99, 0.47].

This pattern of results suggests that while people's likelihood of responding (i.e. providing any response) was not significantly affected by mode, people using an app were significantly more likely to provide complete responses. To investigate this further, percentage of response complete was calculated in terms of how many of the basic questions were attempted when a response was given, with 100% indicating basic completion, (i.e. all five questions had been attempted). Descriptively, apps had a mean completion percentage of 98% (median of 100%), while SMS had a mean completion percentage of 86% (median of 80%). The distribution of percentage completion was negatively skewed and bounded, so a poisson distribution was used for model fitting. The level 2 random intercept was significant (b(SD)=2.68, 95% CI[2.59, 3.55]) . The level 1 model coefficient indicated that there was a significant difference between modes, with those using SMS providing lower percentages complete than those using an app b=-2.69, 95% CI [-4.25, -1.98]. This supports the assertion that mode is significantly associated with response completeness.

While coding the data, it was clear that SMS respondents were not completing one question in particular as required. When asked to rate their mood on a likert scale, many SMS respondents instead provided a qualitative mood descriptor such as "frustrated" or "bored". Though some manner of response had been provided, this was coded as a missing response as it did not conform to the required response format.

Response delay was evaluated by way of number of minutes between a prompt, and response in minutes, with the shortest delay possible set at one minute. As can be expected given this was a response time variable, this response delay was strongly bounded and skewed. Given that this data shape is theoretically expected, rather than transform the data to meet model assumptions, models were fitted using a poisson distribution. The median response delay for responses completed via app was three minutes, while those completed via SMS was four minutes. A logistic multilevel model was fit, with mode as a predictor of receipt of response delay (in minutes), nested by participant at level 1. Again, the level 2 random intercept (b(SD)=0.91, 95% CI [0.87, 1.10]) was significant, but the level 1 model coefficient was not (b=0.15, 95% CI [-0.18, 0.51]), indicating that mode did not significantly affect response delay.

Summarized in Table 1, two chi-square tests were completed to explore differences in participant perceptions of convenience and privacy, based on whether they participated by way of SMS or app. While the two groups did not significantly differ in their perceptions of privacy, those using apps were significantly more likely to rate their data collection mode as having "good" convenience than those using SMS.

Table 1. *Ratings of convenience and privacy by mode*

	Counts		Model Properties		
	App	SMS	χ^2	χ^2 power	Fisher's p
Convenience					
Poor	1	4			
Neutral	8	18	5.956 p=.05	.58	.05
Good	43	36			
Privacy					
Poor	0	2			
Neutral	7	11	2.909 p=.203	.31	.24
Good	46	43			

Discussion

This study examined whether app or SMS provided superior data completeness, response delay, and participant evaluation of privacy and convenience. Collecting data by app or SMS did not impact upon whether or not a response was attempted, whether the response was extraneous or a duplicate, or how promptly participants responded. The response rate for SMS and app respondents was equivalent, promisingly exceeding the average response rate in academic research estimated by Baruch and Holtom (2008). However, mode did significantly impact on response completion. Following the same pattern as in Lim et al. (2010), SMS data was significantly less complete than app data. This may be due to two factors caused by the uncontrolled response format of SMS. Firstly, whilst app respondents had fixed forms in which to provide their answers, the free-text nature of SMS responses allowed participants to respond in a non-standard format (i.e. providing qualitative mood descriptors such as 'fine' rather than requested Likert ratings). Though participants technically answered the question, this data must be considered missing as it cannot be confidently reconciled with the required numeric format. Secondly, apps offer item skipping prevention akin to online surveys, whilst SMS does not. This allows more accidental response omissions to occur in SMS. Given the almost identical overall response rates, this indicates that data collection via app provides superior data completeness, particularly when the usability of the data is contingent on participants following specific response format instructions.

Minimising response delays minimises potential data distortion due to retrospective recall bias (Raphael, 1987). The median response delay of under four minutes for both modes was consistent with the literature using SMS (Conner & Reid, 2012; Lepper et al., 2013), and was better than what may be expected from the literature using apps. This may be because the current study had a more compressed sampling schedule (ten times in a day) than those reviewed in Hofmann and Patel (2014) (three to seven times in a day), thus engendering a greater sense of rush to respond, lest a late response become a missed response. Another possibility is that the current study sampled only from university undergraduates, a population particularly likely to have their mobile telephones nearby at all times, while the studies in Hofmann and Patel (2014) were a mixture of undergraduates and members of the general population. These short response delays are particularly promising for ecological momentary assessment, where researchers seek to tap transient, current thoughts and feelings, as problems of recall bias are minimised when responses are prompt. These results suggest that either app or SMS may be a viable method of data collection where prompt responses are particularly important.

As in previous research using SMS and apps as a means for communicating with participants, perceptions of the privacy and convenience of both modes were generally positive (Akamatsu, Mayer, & Farrelly, 2006b; Broaddus & Dickson-Gomez, 2013; Lim et al., 2010; Matthews et al., 2008). Here, participants who responded via apps were significantly more likely to rate their data collection mode as having "good" convenience than those using SMS. This difference cannot be due to the response platform (as all participants were using iPhones), or the response schedule (which was randomised), suggesting that something may be more convenient about responding via app than SMS. One possibility is that respondents participating via SMS received the questions in an initial SMS, and only prompts when it came time to respond. This resulted in the questions and the input space for answers being separated, thus necessitating scrolling. Conversely, those responding via app were presented with the questions directly next to answer input. This could be clarified in future research, by sending the full SMS questionnaire on each response occasion, rather than just a prompt referring participants to an earlier SMS containing the questionnaire.

This was the first study to directly compare SMS and app response behaviour for self-report psychological research. The difference between the two response modes was made clear by controlling the demographic to only undergraduate students, and the response platform to only iPhones. However, this limits the generalisability of findings. Further investigation is warranted to see how SMS and apps compare in a wider population sample, likely to own different types of mobile telephones, and importantly, across a wider range of ages. Engagement with mobile telephone differs on the basis of age (Devitt & Roker, 2009; Ling, 2002, 2010), which may in turn impact on the viability of using SMS or apps for data collection with a particular age group. For example, teenagers and young adults use SMS heavily in their daily lives (Charlton, Panting, & Hannan, 2002; Pain et al., 2005), and have experience with apps – only a tenth of individuals aged 18-35 have never downloaded an app (Deloitte, 2013). Conversely, older adults use SMS more sparingly (Lobet-maris & Henin, 2002; Mallenius, Rossi, & Tuunainen, 2007), and almost a third of those aged 65 and over have never downloaded an app (Deloitte, 2013). It would be educative to establish whether the relative efficacy of apps and SMS reflect these differing levels of pre-existing mastery.

This paper directly contrasted SMS and app in terms of response rate, response completeness, response delay, and participant evaluation of privacy and convenience. In a self-report, repeated measures paradigm, apps outperformed SMS in terms of data completeness, and positive participant perceptions of the research experience. All else being equal, this suggests that researchers should consider using apps rather than SMS for repeated measures self-report data collection.

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SMS = Send My Survey: Short Message Service for Longitudinal Research

This paper is currently in preparation for submission.

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Repeated measures research allows unique insights into psychological change, and intra-individual variability. It is also very difficult to do. One possible solution is Short Message Service (SMS), a ubiquitous bidirectional mobile telephone-based communication system that is slowly gaining traction as a practical and cost-effective mode for self-report data collection. This paper is the first to examine how SMS performs compared to other research modes in terms of the common threats to repeated measures data collection - attrition, incomplete responses, and delays in responding. 261 participants were randomly assigned to complete a ten item negative mood questionnaire twenty four times via SMS, email, post, or digital device. Some received no reminder prompts, others prompts via SMS, email, or post. SMS produced comparable data quality to postal and email questionnaires, and superior data quality to digital device. SMS performed best when sampling daily, and in combination with SMS reminder prompts. When SMS prompts were used in combination with other modes, response delays were reduced.

Repeated measures research allows robust understanding of individual differences, placing between-subject variation in the context of within-subject variation (Boker, Molenaar, & Nesselroade, 2010; Bolger, Davis, & Rafaeli, 2003; Hedeker & Mermelstein, 2007; Nesselroade & Salthouse, 2004; Shammi, Bosman, & Stuss, 1998). It also allows exploration of how psychological constructs change over time, which is impossible with single measurement data (Bolger et al., 2003; Ployhart & Ward, 2011; Ram & Gerstorf, 2009). The problem is, repeated measures research is difficult to conduct (Ebner-Priemer, Kubiak, & Pawlik, 2009). Attrition over the course of sampling is a particular issue (Little, 1995). Though historically there has been attention paid to difficulties with recruitment, attrition, and dealing with missing data in repeated measures research, there has been less of an emphasis on the possibilities of expanding the methodological repertoire that may address the problems described (Fahrenberg, Myrtek, Pawlik, & Perrez, 2007). One of the most widely used data services worldwide, Short Message Service (SMS) is a ubiquitous bidirectional text-based communication system, compatible with almost all mobile telephones (ACMA, 2013). Establishing its properties as a tool for repeated measures data collection, either alone or in concert with other modes, may contribute to making repeated measures research a more viable option for researchers.

Researchers have somewhat mitigated attrition by carefully choosing their mode of communication, sometimes using multiple modes in concert (Dillman, Smyth, & Christian, 2009). Just as researchers once capitalized on the pre-existing infrastructure and common use of post as a bidirectional communication medium, email has received some attention as data collection tool (Fricker & Schonlau, 2002; Meho, 2006). Adding portability to fixed online surveys, small palm-top computers with dedicated survey capabilities (referred to henceforth as 'digital devices') received some attention for a brief period (Ebner-Priemer & Kubiak, 2007). A relative newcomer to self-report research, Short Message Service (SMS) is gaining traction as a practical and cost-effective mode for data collection (Conner & Reid, 2012).

A researcher may use multiple modes in a single study to prompt responses, or reach a wider range of participants. Postal survey and online instruments have been successfully supplemented by electronic prompts, such as SMS, that remind participants to fill out the questionnaire on schedule (Ashby, Turner, Cross, Mitchell, & Torgerson, 2011; Bolger et al., 2003; Kuntsche & Robert, 2009). Using multiple modes to collect data can help reach more participants (Dillman et al., 2009), but the researcher should be alert for problems of cross-modal invariance. For example, when administered to the same population, online instruments tend to have systematically higher mean and latent means than their paper counterparts (Cole, 2006; Meade, Michels, & Lautenschlager, 2007). These cross-modal differences may be due to the different visual layouts of the modes somehow systematically biasing responses (Jansen, 1985; Richardson & Johnson, 2009).

When choosing between modes for repeated measures sampling, tempo is an important consideration. This is the turnaround from when the questionnaire is made available to participants, and when the researcher can access the response data. Ideally, a researcher should first establish the most meaningful sampling frequency and duration based on theoretical considerations, and then choose the mode that performs best at that tempo (Anstey & Hofer, 2004). This can vary widely: for example, studies examining variability in mood have sampled as often as every fifteen minutes across a single day (Stone, Smyth, Pickering, & Schwartz, 1996), and as infrequently as once every six months (Weinstein et al., 2008). Modes which provide responses as they are completed, such as email and SMS surveys, have the quickest tempo. Traditional paper diaries, where all responses are filled out before posting the survey, and digital devices which store responses for later upload, have the slowest tempo. It may be that a mismatch between the theoretically driven tempo and mode choice could exacerbate the difficulties of collecting usable repeated measures data.

Repeated measures data can be lost, and its quality threatened, by to incomplete responses, non-responses and attrition, and response delays. An incomplete response, usually due to skipped items, can undermine any scale where total scores are calculated and so be equivalent to a missing response. If a participant does not reply on a particular occasion, the whole response is missing (Ashby et al., 2011). Estimates of response rates in self-report psychological research generally fall between 40% and 50% (Baruch & Holtom, 2008; Baruch, 1999; Cook, Heath, & Thompson, 2000; Shih, 2008). Attrition occurs when participants completely stop responding (Goritz & Wolff, 2007). Not only does this diminish sample size, but it can introduce non-response error if those who drop out of the research systematically differ from those who remain (Dillman et al., 2009). Response delay is associated with data completeness. Delayed responses may be more likely to be forgotten, and so become missing responses. It is also associated with data quality. Quick responses minimise response bias, and so the more prompt the response, the more accurate the data is likely to be (Kuntsche & Robert, 2009; Stone, Shiffman, Atienza, & Nebeling, 2007).

Given all of these considerations for optimal data sampling across repeated measurement times, this paper explores the utility of SMS as a tool for repeated measures data collection, comparing it with other bidirectional communication methods used in everyday life (post and email), and a technology that mobile telephones are gradually superseding (digital devices). The modes will be compared across three time scales: sampling daily, weekly, or monthly. Negative mood will be used as an example construct to explore the effect of mode and sampling frequency on response rate, completeness, delay, attrition, content, and respondent reflections on their participation experience.

Method

Participants

Participants were 261 members of the Australian public, and undergraduate students aged 18-65 (*M*=23). Sixty four percent were female. Daily sampling participants were given a course research credit incentive, whilst weekly or monthly sampling participants were given a chance to win a large monetary prize ($300 AU for weekly, and $500 for monthly sampling). The number of participants in each response condition were as described in table 1.

Materials

The initial online survey consisted of demographic information, and the PANAS-X (Watson & Clark, 1999). The ongoing survey consisted of the PANAS-SF negative axis, with participants asked to reflect on their present negative mood state (Watson, Clark, & Tellegen, 1988). To distinguish it from the full PANAS-X, and because only the negative axis was used, it will henceforth be referred to as the PANAS-SF-NA. As part of a separate study, participants also completed a rumination measure.

Table 1. *Participant assignments*

Mode	Prompt	Sampling Frequency		
		Daily	Weekly	Monthly
SMS	None	10	9	-
	SMS	13	9	9
	Email	10	12	-
	Post	-	-	-
Post	None	11	8	-
	SMS	13	7	9
	Email	9	11	-
	Post	-	9	10
Email	None	9	6	-
	SMS	11	9	10
	Email	8	10	9
	Post	-	-	-
Digital device	None	5	4	-
	SMS	7	6	-
	Email	2	6	-
	Post	-	-	-

Note. These cell sizes reflect the number of participants who provided usable data. Ten digital devices were not returned, therefore those participants are not reported here.

Participants responding via SMS used their own mobile telephones and data plans to respond. At the beginning of the repeated measures portion, they were sent the following text.

> *Keep this SMS for the Psych Study. Instructions: Copy each word, then indicate to what extent you feel this way right now, that is, at the present moment. An example correct response = bipedal 5. Use the following scale: 1 = very slightly or not at all, 2 = a little, 3 = moderately, 4 = quite a bit, 5 = extremely. The ten words are: distressed * upset * hostile * irritable * scared * afraid * ashamed * guilty * nervous * jittery. Reply to this text with your response each time. Please check you have completed all TEN words before sending your response. Issues? Contact [researcher email] Thanks!*

A commercial bulk SMS service, SMSbroadcast, was used to schedule and send outgoing messages and aggregate participant responses. This cost $0.10 AU per participant.

Participants responding via email provided the email address they checked most frequently. At the beginning of the repeated measures portion, they were sent the following email.

> *This scale consists of a number of words that describe different feelings and emotions. Press reply to this email, then read each item and then type the appropriate answer next to that word. Indicate to what extent you feel this way right now, that is, at the present moment.*
>
> *Use the following scale to record your answers: 1 (very slightly or not at all)2 (a little) 3 (moderately) 4 (quite a bit) 5 (extremely)*
>
> *distressed*
> *upset*
>
> *hostile*
>
> *irritable*
>
> *scared*
>
> *afraid*
>
> *ashamed*
>
> *guilty*
>
> *nervous*
>
> *jittery*
>
> *Please keep this email until the study is over. If you have any questions, please send them to*
>
> *erin.walsh@anu.edu.au*

For the first year of the study, the researcher's university email account and Microsoft Outlook were used to schedule and send outgoing email messages, and aggregate replies. An unanticipated university-wide change in email service necessitated a move to managing the emails via a Gmail account, and a custom advance-email-scheduling script. These services were free.

Participants responding via post received a single letter with space for 20 survey responses to complete over time. Those responding via post with postal prompts received separate letters, one per sampling occasion, sent on schedual (so the postal survey arriving served as the postal prompt). The survey format via post was as follows.

> *This scale consists of a number of words that describe different feelings and emotions. Read each item and then mark the appropriate answer in the space next to that word. Indicate to what extent you feel this way right now, that is, at the present moment.*
>
> *Use the following scale to record your answers.*
>
> *1 (very slightly or not at all) 2 (a little) 3 (moderately) 4 (quite a bit) 5 (extremely)*
>
> *Time and date____________*
>
> *distressed _______ upset _______ hostile _______ irritable _______*
>
> *scared _______ afraid _______ ashamed _______ guilty _______*
>
> *nervous _______ jittery _______*

All letters contained a postage-paid self-addressed return envelope. Posting to participants, and paying for return postage cost $1 AU per participant. This was a one-off cost for those responding via post with either no prompt, SMS or email prompts. For those in the postal prompt condition, this was the cost per response (coming to $24 AU per participant).

The digital devices used in the current study were PowerCom Reply Ativa pressure-sensitive Touch Screens. Participants responding with these devices were provided with a USB charging cable, stylus, device, and data card (Figure 1).

Figure 1. Digital device and paraphernalia

The survey instructions were pre-loaded onto the device. Participants were presented with each PANAS-SF negative axis word in turn, and a series of touch buttons corresponding to the numbers 0 through 5 to record their response. They were asked to input the date and time after completing each response. Responses were recorded on the data card, rather than in the device's internal memory, allowing the devices themselves to be re-used for multiple participants. The Digital devices were by far the most expensive mode, the fleet of 20 devices and associated support hardware and licensing cost a total of $6,842 AU.

Participants in the conditions with reminders received prompts via SMS or email at 7:00pm. Costing $0.05 per occasion ($1.20 AU total per participant) the prompts read as follows:

> *This is a reminder for the Rumination and Mood study. Please answer the mood questionnaire. Questions? contact [researcher email] Thanks!*

Sent at no cost, the email prompts read as follows:

> *This is a reminder email for the Rumination and Mood study. Please answer the mood questionnaire. If you have any questions, problems, or comments, please contact [researcher email]. Thankyou for your participation!*

Postal prompts consisted of sending a new letter per sampling occasion (rather than one letter with space for all 24 answers). This cost $24 AU per participant.

Design

This study was a 4x4x3 design. Participants were randomly assigned to one of four response modes (SMS, email, postal survey, or digital device) and four prompt conditions (SMS, email, postal survey, or no prompt). Sampling frequency (daily, monthly or weekly) was not randomly assigned. Daily sampling fit within a university semester, and so research credit was a viable incentive. Weekly and monthly sampling would not fit within a single semester, so a lottery cash prize incentive was used. To avoid attrition due to circumstances beyond modes (i.e.

leaving the country upon visa expiration), all participants were recruited on the basis that they expected to be in Australia for the duration of sampling.

Procedure

All participants completed the initial online survey. At this point, they were randomly assigned to response mode and prompt conditions, and the appropriate contact details (mobile number, email or postal address) were recorded. Those assigned to the digital device condition were invited into the university to collect the device and given a demonstration on its use. Participants then embarked on the repeated measures portion, with instructions to complete the PANAS-SF at their designated frequency (daily, weekly or monthly) as close to 7:00pm as possible. Those responding weekly completed the survey each Wednesday night. Those responding monthly were asked to respond on the first day of each month. At the conclusion of sampling, those using a digital device made an appointment with the researcher to return them.

Results

In the following analyses, significance of predictors is often ascertained by multilevel modelling, where a χ^2 test was used to evaluate whether addition of the variable of interest to a null (intercept-only) model significantly improved model fit. These models appropriately incorporated within- and between- subject variance by nesting responses by participant in a two-level hierarchical structure.

Psychological Content

A between-subjects ANOVA of PANAS-NA scores revealed no significant difference between those assigned to different modes, $F(4,255)=0.744$, $p=0.563$. Turning to the repeated measures, collapsing across measurement occasions and participants, the PANAS-SF-NA, postal responses had the lowest (M=14) scores. The mean PANAS-SF-NA score was similar across digital devices, email, and SMS (M=15, M=16, and M=14 respectively). In a multilevel model, with repeated PANAS-SF-NA responses nested by participant, addition of mode as a predictor to a null model of PANAS-SF total score did not significantly improve model fit (χ^2=5.9, p=0.206). This indicated that repeated measures of mood were not significantly different across the data collection modes.

To examine if mode had an impact on the factor structure of the PANAS-SF-NA, factorial invariance was explored as in Vandenberg and Lance (2000), using the Lavaan and SemTools packages in R. Collapsing across measurement occasions (ensuring a large n for analyses, but ignoring the hierarchical nature of the data), the PANAS-SF-NA score demonstrated configural ($\chi^2(172)$=3480, $p<0.01$) and weak ($\chi^2(211)$=3629, $p<0.01$) invariance. This indicated that the same factor structure and comparable loadings were appropriate across modes. However, comparison across modes indicated a lack of strong invariance ($\Delta\chi^2(36)$=148, $p<0.01$), suggesting that latent means and intercepts differ by mode.

Attrition and Non-responses

Overall, participants remained for most of the duration of the study. Only 8% did not provide a single response (i.e. dropping out before the repeated measures portion began), almost all of whom were in the digital device condition: 10 of the 20 devices were not returned. Those who provided at least one response were included in attrition point analyses. Separate linear regressions indicated that neither age (b=0.03, p=0.64) nor gender (b=0.08, p=0.95) were associated with attrition point.

The median attrition point, where the greatest number of participants stopped responding, was the 17^{th} sampling occasion (Figure 2).

Participants in the daily sampling condition tended to remain in the study longer, with a median attrition point of the 18^{th} sampling occasion, as opposed to the 16^{th} for the weekly and monthly sampling frequencies (Figure 3). A single level regression revealed no significant difference in attrition point depending on sampling frequency. Sampling frequency was consequently used as a grouping rather than predictor variable for examining attrition, resulting in a two-level multilevel model with attrition point nested by sampling frequency. Descriptively, SMS had the earliest median attrition point (the 12^{th} occasion), compared to post (16^{th}), email (18^{th}) or digital device (21^{st}). There was a significant difference in attrition point across modes (χ^2=9.71, p=0.02, Figure 1, Table 2). Prompt was not significantly associated with attrition point, either as sole predictor (χ^2=6.64, p=0.15), or in addition to mode (χ^2=5.29, p=0.25).

Table 2. *Attrition point multilevel model coefficients*

Parameter	Model
	Fixed effects
Intercept	12.87 (1.16)
Mode (post)	0.55 (1.5)
Mode (email)	2.01 (1.6)
Mode (digital device)	6.37 (2.1)
	Random parameters
-2LL	-613
AIC	1238

Note. Standard errors for fixed effects model coefficients are in parentheses. The model is structured so attrition point is nested by participant (level 1) and sampling frequency (level 2). Comparison group for mode is SMS.

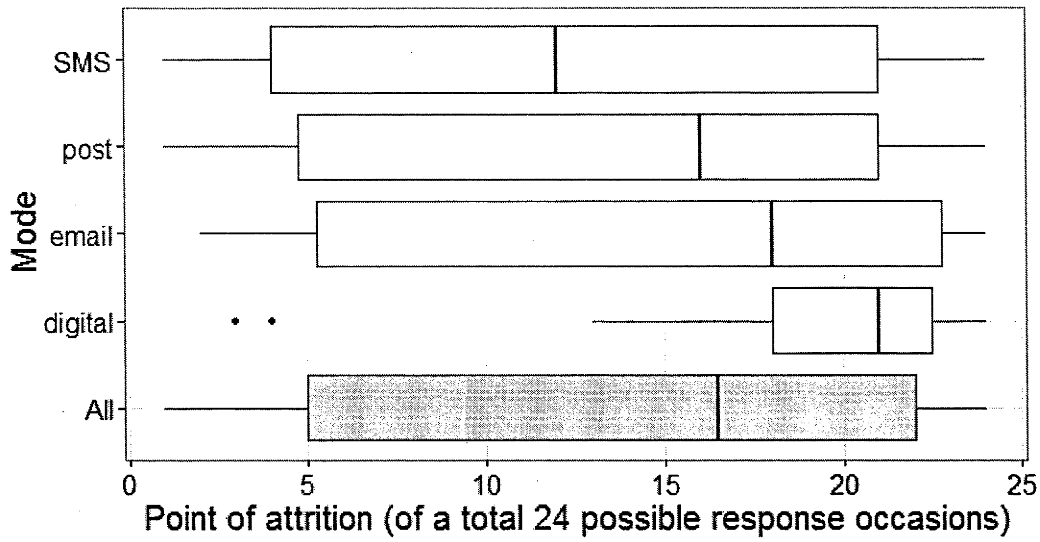

Figure 2. Attrition point by mode, combining across sampling frequency and prompt conditions.
Note. The grey 'all' category pools across modes to provide an overview of the overall attrition point.

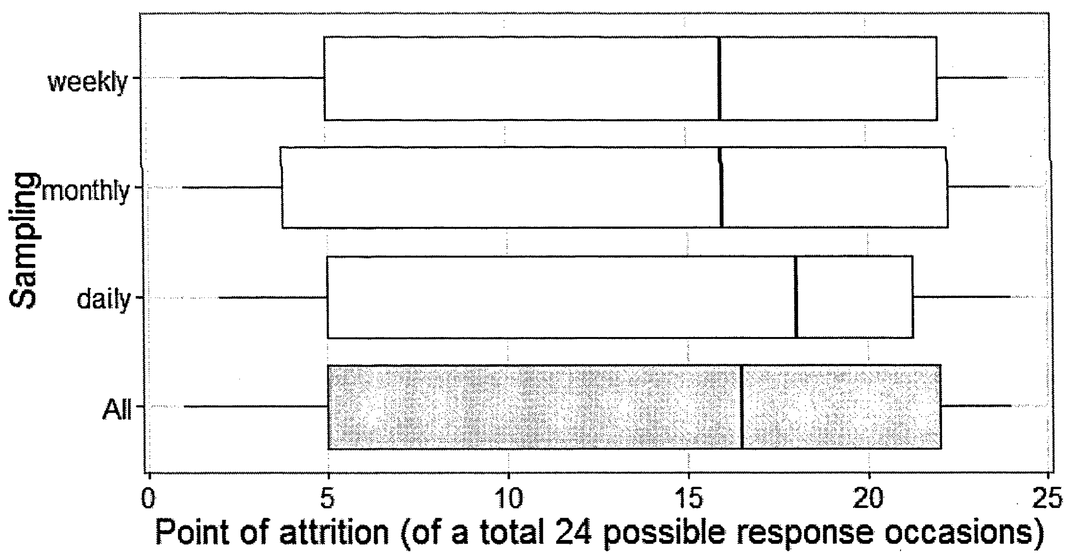

Figure 3. Attrition point by sampling frequency, combining across mode and prompt conditions.
Note. The grey 'all' category pools across sampling frequencies to provide an overview of the overall attrition point.

Remaining in the study is not synonymous with consistent responding, as one could miss many response occasions and then answer just once or twice during later sampling occasions. Overall, there was a relatively high 58% non-response rate. As in Figure 3, descriptively, sampling daily had the fewest missing responses (38%), followed by monthly (41%), and weekly (72%). Overall, email had the fewest missing responses (50%), followed by digital device (54%), and post and SMS (both 63%). Sampling frequency (χ^2=95, p<0.01) was significantly associated with number of responses, and addition of mode (χ^2=41.7, p<0.01), and prompt (χ^2=40.1, p<0.01) further improved model fit (see Table 3 for model coefficients). The number of variables and sample size led to non-convergence of models investigating interactions in a multilevel sense, however a 3x4x4 ANOVA agnostic to the hierarchal nature of the data supported the presence of a three-way significant interaction between sampling frequency, mode, and prompt; $F(6,6769)$=6.281, p<0.01.

Visual inspection of Figure 3 gives some insight into the nature of this interaction. Response modes each have their own column, sampling frequencies their own row. Box plots within the panels are separated by prompt condition. Viewing the figure row-wise, it is clear that participants responded on more occasions when sampling was daily, compared to weekly or monthly. Viewing the figure row-wise, SMS and digital devices provided the most data during daily sampling, and email during weekly and monthly sampling. Note that SMS responses for daily sampling are numerous, but for weekly or monthly sampling are less numerous. This same pattern, though less pronounced, is visible in the post condition. There is little difference in number of responses across sampling frequencies in the email and digital devices conditions. Examining the prompts within the panels, response rates are overall lower in the no-prompt condition, except for digital devices. Email prompts are associated with more missing responses than no prompts at all when sampling via SMS. Prompts aligned with their response mode (SMS/SMS, email/email, and post/post) were associated with the highest response rates.

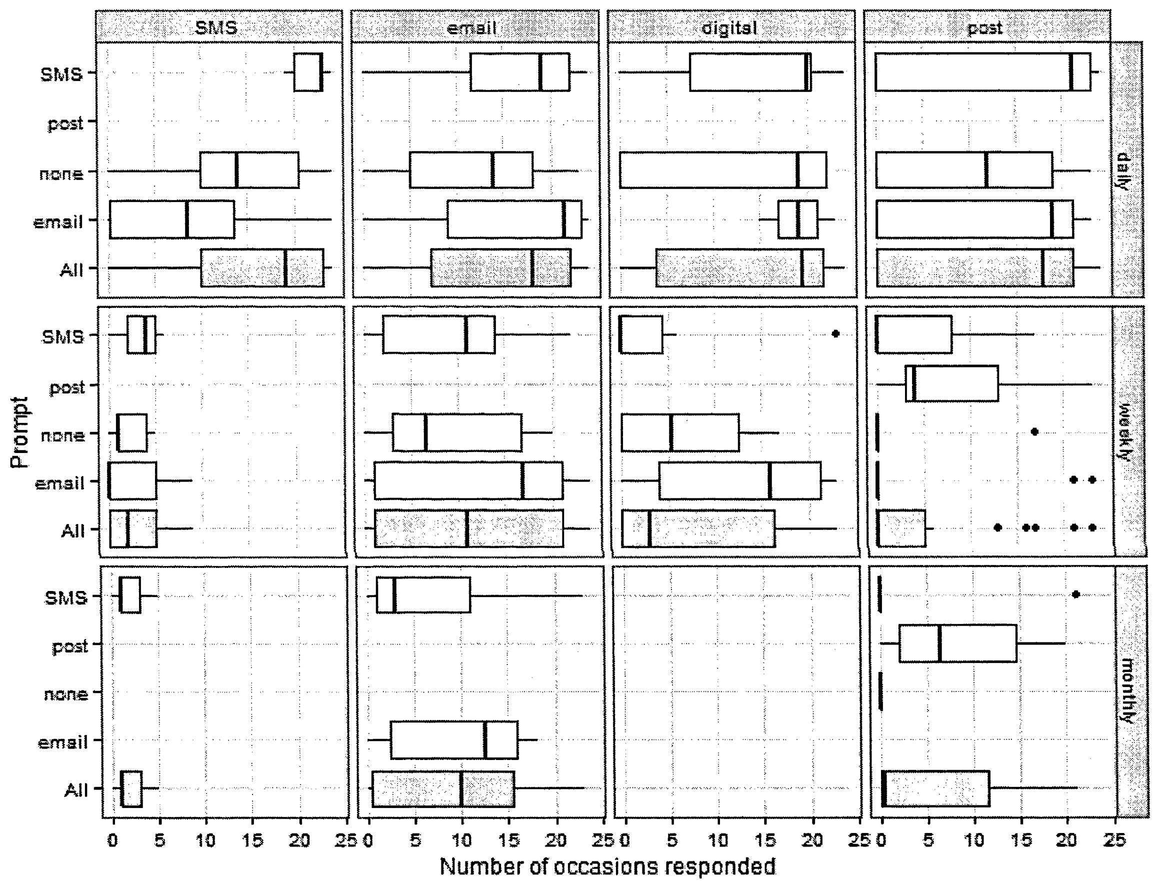

Figure 4. Completed responses by mode, prompt, and sampling frequency.

Note. Entirely empty portions reflect that condition had no participants. The grey 'all' category pools across all prompt conditions within each facet to facilitate comparison between modes and sampling frequency conditions.

Table 3. *Number of responses multilevel model coefficients*

Parameter	Model 1	Model 2	Model 3
	Fixed effects		
Intercept	0.43 (0.02)	0.48 (0.04)	0.52 (0.05)
Frequency (Weekly)	0.35 (0.04)	0.31 (0.04)	0.35 (0.04)
Frequency (Monthly)	0.34 (0.03)	0.30 (0.05)	0.39 (0.05)
Mode (post)		0.06 (0.04)	0.15 (0.05)
Mode (email)		-0.17 (0.04)	-0.17 (0.06)
Mode (digital device)		-0.07 (0.07)	-0.06 (0.06)
Prompt (SMS)			0.08 (0.04)
Prompt (post)			-0.44 (0.08)
Prompt (email)			-0.15 (0.05)
	Random parameters		
-2LL	-2241	-2161	-2147
AIC	4492	4338	4316

Note. Standard errors are in parentheses. $p<0.01$. All models are nested by participant (level 1) and sampling frequency (level 2). Comparison group for frequency is daily sampling. Comparison group for mode is SMS. Comparison group for prompt is no prompt.

Response completeness

Of the responses received, most (93%) were complete (i.e. all 10 items of the PANAS-SF-NA were completed). Descriptively, weekly (93% complete) and monthly (99% complete) responses were more complete than daily (87% complete) responses. This was significant ($\chi^2=20$, $p<0.01$, Table 4 model 1). Descriptively, digital devices had the least complete responses (67% complete), followed by email (91%), SMS (96%) and post (99%). Addition of a mode as a predictor of response completeness to the model already containing sampling frequency significantly improved model fit (χ^2=10, p=0.03, Table 4 model 2). Further addition of prompt to this model did not significantly improve fit (χ^2=8.4, p=0.07), suggesting that sampling frequency and mode, but not prompts, impact on response completeness.

Table 4. *Response completeness multilevel model parameters*

Parameter	Model 1	Model 2
	Fixed effects	
Intercept	9.066 (0.13)	9.007
Frequency (Weekly)	0.64 (0.17)	0.61 (0.2)
Frequency (Monthly)	0.77 (0.21)	0.69 (0.21)
Mode (post)		0.341 (0.210)
Mode (email)		-0.24 (0.20)
Mode (digital device)		-0.17 (0.26)
	Random parameters	
-2LL	-7146	-7141
AIC	14303	14301

Note. Standard errors are in parentheses. All models are nested by participant (level 1) and sampling frequency (level 2). Comparison group for sampling frequency is daily. Comparison group for mode is SMS. Comparison group for prompt is no prompt.

Response Delay

The majority (82%) of responses were received on the same day as the prompt. Most (92%) were received after, rather than before the designated response time. The two modes where the time stamp was self-reported (post and digital device) were significantly more likely to have early responses (χ^2=65.22, p<0.01, Table 5 model 1) than those where the time stamp was automatically recorded (SMS and email). Receipt of any form of prompt was associated with a diminished likelihood to respond early (χ^2=9.34, p=0.02, Table 5 model 2).

Table 5. *Early responses multilevel model parameters*

Parameter	Model 1	Model 2
	Fixed effects	
Intercept	-5.89 (0.70)	-5.01 (0.72)
Mode (digital)	2.07 (0.70)	2.23 (0.87)
Mode (email)	0.37 (0.89)	0.59 (0.06)
Mode (post)	4.22 (0.76)	4.59 (0.78)
Prompt (SMS)		-0.94 (0.55)
Prompt (post)		-1.74 (0.72)
Prompt (email)		-1.58 (0.65)
	Random parameters	
-2LL	-453	-449
AIC	919	916

Note. Standard errors are in parentheses. All models are nested by participant (level 1) and sampling frequency (level 2). Comparison group for mode is SMS. Comparison group for prompt is no prompt.

Across all conditions and modes, responses were generally completed within a median of fifty minutes from 7:00pm. With a median delay of 29 minutes when sampling daily, 126 minutes sampling weekly, and 175 minutes sampling monthly, higher sampling frequencies were associated with significant shorter response delays (χ^2=109, p<0.01, Table 7 model 1). Looking at the median response delay by mode (Table 6), response delays clearly increase across sampling frequencies for SMS respondents, but not for post, email, or digital device respondents. Addition of mode as a predictor beyond sampling frequency did not significantly improve model fit (χ^2=1.3, p=0.85). However, prompt was significantly associated with response delay (χ^2=22.79, p<0.01, Table 7 model 2). All formats of prompts decreased response delay, with SMS prompts decreasing the delay the most.

Table 6. *Median response delay by mode, prompt and sampling frequency*

	Daily	Weekly	Monthly
		Mode	
SMS	35	81	1324
Post	6.5	60	60
Email	47	301	289
Digital device	62	133	-
		Prompt	
None	56	180	-
SMS	18	64	30
Email	30	150	1187
Post	-	120	150

Note. Postal and digital response delays are calculated from self-reported time of completion, SMS and email response delays are calculated from automatic time stamps. The numbers presented under the 'Mode' heading average across prompt conditions, and the numbers presented under the 'Prompt' heading average across mode conditions.

Table 7. *Response delay multilevel model parameters*

Parameter	Model 1	Model 2
	Fixed effects	
Intercept	114.3 (105.6)	241 (171)
Frequency (weekly sampling)	606.9 (185.6)	
Frequency (monthly sampling)	3013.8 (250.3)	
Prompt (SMS)		-204.1 (207)
Prompt (post)		1409 (376)
Prompt (email)		-124 (187)
	Random parameters	
-2LL	-23745	-23733
AIC	47499	47485

Note. Standard errors are in parentheses. All models are nested by participant (level 1). Comparison group for frequency is daily sampling. Comparison group for prompt is no prompt.

Discussion

This paper examined the utility of SMS as a tool for repeated measures data collection across three time scales (daily, weekly, and monthly) and in comparison with three other data collection methods (email, post, and digital device). Digital devices were by far the most expensive mode, both in terms of initial outlay and handset loss. The construct of negative mood was used to facilitate the emphasis on the methodological aspects of data collection. The mode used to respond was not significantly associated with self-reported negative mood, indicating cross-mode measurement invariance was not violated. PANAS-SF-NA scores were generally low, reflecting a psychologically healthy sample.

In line with previous findings comparing postal and online scores, postal surveys had the lowest mean and latent mean PANAS-SF-NA scores (Cole, 2006;

Meade et al., 2007; Vecchione, Alessandri, & Barbaranelli, 2012). Given that all of the other modes in the current study involved some manner of technology where it is easy to backspace and replace an answer, perhaps the lower postal scores reflect a more cautious approach to responding stemming from the comparative permanence of writing on paper. Regardless of the cause, a researcher conducting self-report research using multiple modes should be aware that paper administration is likely to have lower scores in comparison with SMS (and other modes of administration). This systematic mode-based bias may add noise to conclusions in multi-modal paradigms, or where SMS, email, or digital device self-report repeated measures data is intended to be compared with previous research that used paper responses.

There was a high non-response rate overall: participants failed to respond on nearly two thirds of occasions. This was greater than estimates for self-report response rates in the psychological literature (Baruch & Holtom, 2008; Baruch, 1999; Cook, Heath, & Thompson, 2000; Shih, 2008), and likely due to the necessarily artificial element of the current study design. The sampling duration and frequency was intentionally extended to provide ample scope for attrition to occur, and foreseeable sampling and tempo mismatches (i.e. using SMS to sample on a monthly basis) were used. This limits the conclusions that can be drawn regarding the expected response rate for each mode at each sampling frequency, but does not constrain the validity of discussion of attrition point, or *comparison* of response behaviour across modes.

Response behaviours were impacted on by sampling frequency. Daily (rather than weekly or monthly) sampling was associated with participants remaining in the study for more response occasions, a higher response rate, and shorter response delays. Given that a reasonable portion of participants received prompts, this difference cannot be due to simply forgetting to respond. This may be because of perceived burden. Though objectively all participants were required to commit an equal amount of time and effort to responding (as all were asked to respond on twenty four occasions), a longer sampling period can subjectively feel more burdensome (Ebner-Priemer & Kubiak, 2007). However, this finding is muddied by a shortcoming of the current study - participants in different sampling frequencies were offered different incentives. Daily sampling was given a guaranteed course credit, as opposed to weekly and monthly sampling a lottery for a cash prize. Further study is required to disentangle the possible confound of different incentives from the impact of perceived burden on response behaviours at different sampling frequencies. Despite this limitation, the use of different sampling frequencies has uncovered some useful information.

The utility of SMS as a data collection mode was highly contingent on sampling frequency. SMS performed at its best in terms of maximum response rates and minimum response delays during daily sampling. Email, however, produced similar response behaviour regardless of sampling frequency. Compared to the other modes, SMS had the earliest attrition point. The pattern of response rates and attrition suggested that once they missed a few responses, SMS participants dropped out entirely. Because SMS follow-up reminders for missed responses can improve response rates (e.g. as in Aguilera & Muñoz, 2011; Palmier-Claus et al., 2013), a clear direction for future investigation is examining whether follow-up reminders can effectively reduce attrition amongst SMS respondents.

Response completeness was high (an average of above 90%) in SMS, postal, and email responses. Digital devices had the least complete responses, perhaps because typing responses was particularly difficult – typing on a touch screen is more laborious than writing by hand or on a keyboard, and the digital device touchscreen worked on the basis of pressure input, a less precise technology than the capacitive touch interfaces used on most modern smartphones. In daily and weekly sampling, SMS had the second shortest median response delay, after postal surveys. This result is puzzling, as one would expect people to have more ready access to their mobile phone than a postal survey that is unlikely to be carried with the participant. The most likely explanation is the limitation of self-report time stamping. It is quite possible that participants responding via post felt pressure to provide timely responses, and therefore reported the time and date they thought the researcher wanted. Drawing only from the automatically time-stamped data, it seems SMS is a good option for comparatively short response delays when sampling daily or weekly, but email is more appropriate when sampling monthly.

As in the wider literature, participants receiving reminder prompts tended to have higher response rates (Ashby et al., 2011; Bolger et al., 2003). Whether a participant received prompts was not associated with response completeness, suggesting that prompts acted primarily as a reminder to initiate a response, rather than to increase engagement with the questions themselves. Prompts were useful in promoting timely responses; a prompt from any mode was associated with a shorter response delay, and a diminished likelihood to respond early. The reduction in early responses may be because those receiving prompts did not attempt to independently remember to respond on time, and so made fewer timing mistakes. SMS prompts were associated with the shortest response delays. Given that the mode used to respond did not impact on response delays, this suggests researchers seeking to minimise the response delay should strongly consider reminder prompts.

The combination of prompt and data collection mode was important. Prompts aligned with their response modes were most successful in improving response rates, whilst mismatched prompt/mode combinations could be problematic. Email prompts were more detrimental to response delay than no prompts at all when sampling via SMS. SMS prompts were as ineffective as no prompts when responding via postal survey. This likely relates to the tempo of data collection. Participants responding via SMS can immediately send a reply in response to an SMS prompt, but have to wait until they have email access to receive an email prompt and subsequently reply. Participants responding via postal survey may receive an SMS when they don't have access to the survey, file the message away for future reference, and forget about it. These results suggest that, regardless of the sampling frequency, the most effective mode to prompt participants in repeated measures research is the same mode they are using to respond with.

In summary, SMS held its own in comparison with more established self-report repeated measures research modes. Though more expensive than email, it was cheaper than post and drastically cheaper than digital devices. Using SMS did not impact negatively on construct validity, as in the current study, the psychological content of the data collected was largely invariant across modes (barring an expected but not well explained lower mean scores in paper as opposed to other modes). Sampling frequency had a marked impact on SMS response behaviour. Participants responding via SMS tended to drop out of research sooner, however SMS follow-ups may improve this. The response rate, completeness and delay compared favourably with other modes, but only when sampling daily. As a response mode for self-report repeated measures research, SMS is most useful when used at a higher sampling frequency, in combination with SMS reminder prompts.

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Applying cross-language principles to cross-mode measurement invariances

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This paper is currently under review in *Psychological Reports*.

As technology advances, researchers encounter an ever-expanding choice of different data collection modes. Administration of instruments in modes they were not developed in (for example, administering an originally paper survey online) is increasingly common, and multi-method research is on the rise. Yet there is a lack of research comparing the impact of mode on administration, perhaps due to a lack of a verified procedure and analysis for comparison. This study established how design and analytical techniques from the cross-language literature can be applied to investigate cross-mode measurement invariance. Repeated administration of the same instrument using different data collection modes allowed for within-subjects comparison of the impact of mode on responses while controlling for individual differences. Subsequent comparison examining Cronbach's alpha, total scores, total score distributions, and multi-group factor analysis offered mutually complimentary insights into cross-mode equivalence. To demonstrate the application of this procedure and analysis, fifty five Chinese-English bilingual participants completed four variants (English/Online, English/SMS, Chinese/Online, and Chinese/SMS) of the same 20-item questionnaire in a randomised order, two days apart. Results demonstrated the feasibility and benefits of applying techniques from the cross-language translation literature to investigation of cross-mode equivalence.

An invariant measurement will produce the same representation of a construct regardless of the context surrounding its administration (Stein, Lee, & Jones, 2010). As noted by Vandenberg and Lance (2000), any evaluation of group differences is predicated on the assumption of measurement invariance across groups. If that assumption is violated, the validity of conclusions are threatened (Mullen, 2013). It is therefore important to investigate whether measurement invariance is threatened, and if so, to what degree (Borsboom, 2006). One often overlooked threat to measurement invariance is administering an instrument using different modes. There is a growing trend of using multiple modes to collect data in a single research project (De Beuckelaer & Lievens, 2009). There are strong rationales for using multiple modes for data collection, such as using particular modes to access particular populations (Dillman, Smyth, & Christian, 2009). With the transition from reliance on postal to online survey, and the new possibilities offered by mobile telephones, instruments developed and validated in one mode are increasingly being administered in another. It is likely that this translation across modes could threaten the assumption of measurement invariance, a proposition that should be investigated. Even when using the same mode, wording (Schuman & Presser, 1977), spacing (Smith, 1993), length (Dillman, Sinclair & Clark, 1993), and amount of space afforded for responses (Fuchs, 2009) can impact on responses. All of these variables can vary by mode, as different modes have dissimilar visual layouts (consider a scrollable computer text versus a static printed page), and response procedures (one cannot click a box in a paper survey). There is some research showing that the scores on a number of questionnaires significantly differ depending on whether they were administered by postal or online survey (Cole, 2006; Meade, Michels, & Lautenschlager, 2007; Vecchione, Alessandri, & Barbaranelli, 2012), but there remains considerable scope for further investigation of cross-mode translation effects. There is much theoretical and procedural guidance to be gained from turning to the literature surrounding a conceptually related, and more widely examined topic - cross-language translations.

There has been a considerable increase in cross-cultural and cross-linguistic research in the past decade (Schmitt & Kuljanin, 2008; Stein et al., 2010). As in cross-mode translations, cross-language translations typically follow an imposed-etic approach, where a measure is developed in one language and is later translated into other languages for administration, rather than being simultaneously developed in the languages in which it will be ultimately administered (Ryan, Chan, Ployhart, & Slade, 1999). Historically, the cross-language literature primarily focussed on means, using total score and factor structure equivalence to set boundaries for acceptable differences between the original and translated instruments (Byrne & Campbell, 1999; Sanchez, Spector, & Cooper, 2005). Now, more attention is being paid to multi-method analytical approaches. These go beyond means, examining the shape of item and score distributions, and factor equivalence in terms of item weighting, and latent mean and intercept equivalence (Schmitt & Kuljanin, 2008; Vandenberg & Lance, 2000).

One of the most stringent methods of exploring measurement invariance in the context of a cross-language translation is the use of bilingual individuals completing the same measure on multiple occasions, in different languages, with some time left between occasions to counteract learning or practise effects (Sanchez et al., 2005). This is not a perfect solution because bilingual individuals may differ considerably from monolingual individuals culturally, but it does provide a baseline of the cross-language variance that may be expected in the broader application of the instrument. Cross-mode research fits well within this procedural framework; just as within-subjects administration provides a reasonably clear picture of how much an instrument varies due to language and translation, so it can provide information about how much an instrument varies due to mode of administration.

Although the cross-language and cross-mode literatures share statistical and methodological procedures, it should be noted that they do not have common causes of measurement variance. While cross-modal differences are largely attributable to different layouts and response formats, measurement invariance in cross-language translations is threatened by differences in word meaning or interpretation, and cross-cultural differences in how a psychological construct is understood (Hui & Triandis, 1985; Mullen, 2013; Ryan et al., 1999; Sanchez et al., 2005; Vandenberg & Lance, 2000). Nonetheless, simultaneous investigation of cross-mode and cross-language measurement invariance will provide a strong theoretical and statistical framework for investigating measurement invariance across modes, and could help to clarify how similar the patterns of measurement variance are across languages and modes. Because standards for acceptable differences across languages are well established, the difference between languages can form a standard of comparison for the difference across modes. To do this, two distinct modes, and two distinct languages must be selected.

Online surveys have become a very common tool used in self-report psychological research because they facilitate the collection of large amounts of data in a format convenient for participants. Once collected, the data is easily parsed by researchers (Kraut et al., 2004). Short Message Service (SMS) has only recently been used as a tool for self-report research, but is growing in popularity due to its convenience and suitability for ambulatory assessment. Both online and SMS are primarily text-based and both are cost-effective and convenient as they make use of participant's pre-existing access to infrastructure (computers or mobile phones). But, while the number of questions and length of responses to online surveys is very large, SMS has a strict character limit (160 characters, or up to 600 characters if multiple messages are stitched together). The portability and unobtrusiveness of SMS makes it an excellent tool for repeated measures ambulatory assessment regardless of participant location (Haller, Sanci, Sawyer, Coffey, & Patton, 2006), while accessibility and question-flow programmability of online surveys make them an excellent tool for more detailed, in-depth surveys (Kraut et al., 2004). It is timely to establish cross-mode measurement invariance for these two different modes, as researchers are beginning to use SMS to collect data using instruments originally designed for online or pencil and paper surveys (Conner & Reid, 2012). Particularly in repeated measures research, it is important to scrutinise assumptions of invariance where online or paper surveys are used at baseline, and follow-up measures are administered using some other mode.

English and Chinese hail from different etymological bases, possess different semantic structures, and have very different written forms (Sanchez et al., 2005). Notably, Chinese is far more compact and complex than the more phonographical representations of written English. As well as providing a distinct linguistic basis for the current investigation, the choice of Chinese speaking participants is pertinent to the modes.

In both Australia and China, mobile phone ownership is ubiquitous, and SMS usage is very common (ACMA, 2011; Latham, 2007; Leung, 2007; Ombudsman, 2011; Sangwan & Pau, 2005; Yan, Gong, & Thong, 2006). However, internet access is not equivalent across the two countries. Ninety percent of the Australian population having access, while only forty six percent of the Chinese population do ("Internet Live Stats", 2015). SMS has a potentially wider reach than online surveys in China, as it is used by a larger and more demographically diverse proportion of the Chinese population than the internet (Latham, 2007). This could be capitalised on by psychological researchers seeking to collect data from hitherto difficult to reach demographics. Just as previous shifts in research methods (for example, from paper to online) often involved cross-mode translation, SMS may be used to administer instruments originally developed for pen-and-paper or online administration. Because of this, understanding potential measurement invariance pitfalls of administering an instrument via SMS, and particularly in Chinese, is informative in examining the possibility of expanding the reach of self-report research in China.

In an attempt to redress the lack of verified techniques available to compare the impact of mode on administration, the current study aims to demonstrate how the context of cross-language translation, and techniques used in the cross-language literature, can be applied to investigating measurement invariance of a cross-mode translation. This is achieved by within-subjects administration of four versions of the same instrument, two languages and two modes. We also selected a combination of languages (English and Chinese) and modes (online and SMS) that may be particularly useful to researchers who may be considering broadening the reach of self-report research carried out in China.

Method

Participants

Fifty five Chinese-English bilingual undergraduate students aged 17-27 (M=20, SD=2) participated in return for a choice of course credit, or a small artwork drawn to their specifications. Thirty percent of the sample was male. English language proficiency was assumed due to their status as students at an English-only tertiary institution[4]. Sixteen percent reported that English was their most used language in the past year, while 76% reported that their most used language in the past year was Chinese (the remainder did not specify). Eighty three percent listed Chinese as their first language. Participants had spoken Chinese for a median of 18 years (ranging from 1 to 27 years).

Materials

The Ruminative Thought Styles Questionnaire (RTS; Brinker & Dozios, 2009) is an English-language 20-item self-report measure of rumination, where respondents rate how well a statement describes them on a scale of 1 (not at all) to 7 (very well). The RTS was administered both in its original English language form, and a Chinese language translation from (Walsh, Shou, Han & Brinker, 2015).

Procedure

After recruitment via an internal university appointments system, participants were directed to an online survey. This provided information about the study in English, and requested demographic information in Chinese. Participants were informed that

[4] An Academic IELTS overall scote of at least 6.5; OR a paper-based TOEFL score of at least 570; OR a web based TOEFL score of 80, a Cambridge CAE advanced score of at least 80; OR a PTE academic score of at least 64 is a prerequisite for attendance at the university we sampled from.

the same instrument would be completed in Chinese and English, via SMS and email. Unless participants specified particular scheduling preferences, such as days or times to avoid, they were informed they would be asked to complete the questionnaires at 2pm across the following week.

Participants were then prompted to complete the RTS in each of the four conditions: online in English, online in Chinese, SMS in Chinese, and SMS in English. The order of completion was randomized across participants, i.e. some began via SMS, while others via online survey. Prompts to complete the RTS were sent by email (for the online completions) or SMS (for SMS completions), in the same language as the following RTS (i.e. prompts to complete the Chinese-language version were sent in Chinese). After the RTS, participants were asked to rate the difficulty of responding on a scale of 0 (very difficult) to 5 (not at all difficult), in the same language (Chinese or English) as the preceding RTS. All Chinese used in the study was the simplified written form.

Email prompts consisted of a link to the online questionnaire, while SMS prompts began with instructions about how to complete the instrument and notifying participants they would receive the instrument in 15 minutes. Due to character count limitations, the SMS version of the RTS in both English and Chinese was sent in four 5-item chunks, labelled by a header of "RTS 1 of 4", "RTS 2 of 4" and so on. To minimize practice effects, there was a minimum of two days (48 hours) between each completion. To maintain equivalence between SMS and online completions, the online version of administration did not force responses to all questions, as there is no way to force responses via SMS. The researcher was not present at any RTS completions, though they were available via email if clarification was required. Participants missing responses were excluded from analyses.

Results

Due to non-responses, or completions with missing and out of range items (i.e. responses of 0 or 8), there was a total of 158 RTS completions for analysis. Logistic regression revealed no relationship between RTS score and the demographic characteristics of gender (b=-3.8, p=0.24), age (b=1.29, p=0.06), or how long Chinese had been spoken (b=0.52, p=0.07). Similarly, there was no association between RTS score and study design characteristics of order of administration (b=0.01, p=0.19), or which incentive participants were offered (b=-0.01, p=0.08). Consequently, the following analyses do not control for any of these factors.

Response difficulty

Generally participants found it quite easy to respond (median difficulty of 4, where 0 = very difficult and 5= very easy, see Table 1). Pearson's Chi-squared test with simulated p-value (based on 2000 replicates) indicated that mode does significantly impact on difficulty of response, $\chi^2 = 39.3091$, $p<0.01$, with online responses being slightly easier than SMS responses.

Table 1: comparative descriptive properties across each RTS administration.

		RTS properties				
		Total score				
		M	*SD*	*n*	α	MDR
English	SMS	86	18	42	0.87	3
	Online	83	18	40	0.88	4
Chinese	SMS	83	20	42	0.89	3
	Online	88	19	38	0.88	4

Note. *n* = number of usable completions in that condition. α = Cronbach's alpha. MDR = median difficulty rating.

Total score RTS equivalence

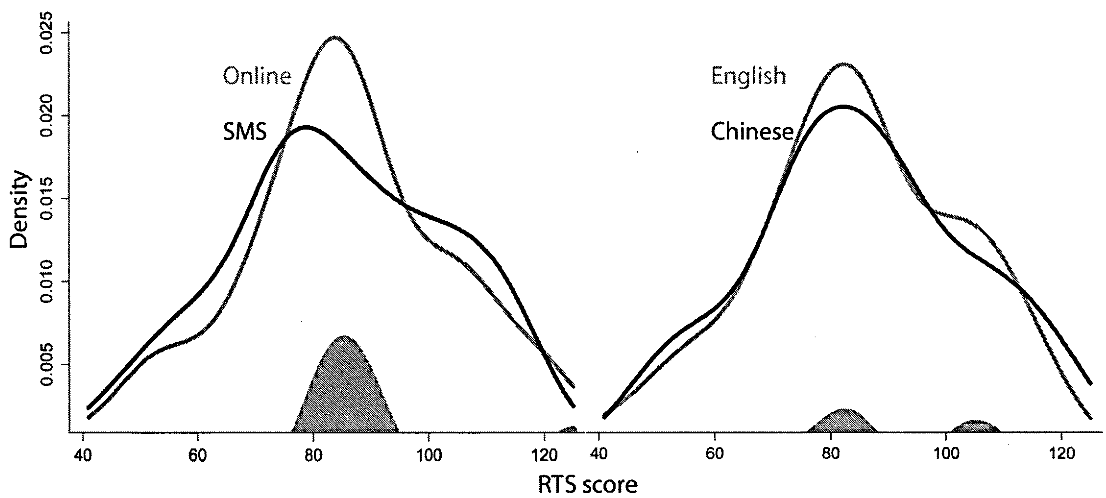

Figure 1: Density plots showing the distributions of total RTS score.

Note. Difference between densities is displayed as the solid grey area.

See Table 1 for an overview of the descriptive properties of the four RTS completions. The RTS in all conditions demonstrated strong internal consistency, with high Cronbach's α[5]. Overall, logistic regression with response condition (language x mode) predicting total RTS scores found no significant differences depending on the language or mode of administration. Comparing across languages, there was a non-significant total score difference of 2.22, $t(83)=0.6$, $p=0.53$, 95% CI [-7.9, 8.68], $d=0.18$. Comparing across modes, there was a non-significant total score difference of 1.19, $t(78)=0.084$, $p=0.93$, 95% CI [-9.32,4.88], $d=0.11$. Having compared totals, Steel's multiple comparisons test was used to explore whether the distribution of the total RTS scores significantly differed across administrations. This

[5] This should be interpreted with caution, as the first eigenvalue in exploratory factor analysis for a single factor solution for all groups was ≈4.2, just short of the threshold recommended by Yurdugul (2008) for reliable estimation of Chronbach's alpha with a small sample size.

test is essentially a series of pairwise Wilcoxon tests as implemented in R by Scholz, Zhu, and Scholz[6]. The following results are based on 1000 simulations. As can be seen in Figure 1, the distributions when comparing across modes and languages was very similar. When comparing all conditions, the null hypothesis that the scores shared the same underlying distribution was not rejected (test statistic=-1.28, p=0.193). The same conclusion was reached when just comparing across languages (test statistic=-0.41, p=0.346), and when just comparing across modes (test statistic=-0.20, p=0.451).

Factor structure RTS equivalence

For each condition, despite the relatively small sample size, Bartlett's test of sphericity (χ^2 ranged from 444 – 565, all p<0.001) and Kaiser-Meyer-Olkin Measure of Sampling Adequacy tests (KMO ranged from 0.58 – 0.61) indicated suitability for factor analysis. Two multi-group factor analyses were undertaken to examine whether the factor structure of the RTS meaningfully differed across languages, or modes. The specifics of multi-group confirmatory factor analysis used here were established in Vandenberg and Lance (2000). Breifly, the analysis constrains parameters of the factor model across groups, and then evaluates how well the model fits each group's data. Significance indicates that the constrained model adequately fits the data from each group, and thus the factor structures are equivalent with regards to the constrained parameters. There are four steps of invariance in this process. Configural invariance constrains only the factor structure (here, the single factor structure of the RTS). Weak invariance constrains the structure and the

[6] Scholz, F., Zhu, A., Scholz, M. F., & SuppDists, D. (2012). Package 'kSamples'.

loadings, while Strong invariance constrains the structure, loadings and intercepts. Finally, general invariance constrains the structure, loadings, intercepts, and means. Significance is found by comparing the fit of each increasingly constrained model against the model before it, expressed in a χ^2 test and Comparative Fit Indices; these analyses were carried out using the semTools package in R (Pornprasertmanit, Miller, Schoemann & Rosseel, 2013). As can be seen in Table 2, the RTS demonstrated General invariance across languages and modes.

Table 2: *Multigroup factor analysis outcomes*

Invariance	Comparison across languages				Comparison across modes			
	χ^2	DF	p	CFI	χ^2	DF	p	CFI
Configural	1090	340	<0.01	0.503	1061	340	<0.01	0.514
Weak	1100	359	<0.01	0.509	1076	359	<0.01	0.517
Strong	1119	378	<0.01	0.509	1087	378	<0.01	0.522
General	1119	379	<0.01	0.509	1088	379	<0.01	0.522

Note. CFI = Comparative Fit Indices.

Discussion

This study demonstrated how the techniques used in the cross-language literature can be applied to investigate cross-mode measurement invariance. Following the gold standard of administering instrument translations to bilingual individuals (Sanchez et al., 2005), this study used repeated within-subjects administration of an instrument by different modes. This was followed by the multi-method analytical approach recommended by Schmitt and Kuljanin (2008) and Vandenberg and Lance (2000), which examined cross-mode equivalence in terms of means, distribution shape, and factor invariance. Results demonstrated the feasibility and utility of applying the approach taken by the cross-language literature to an investigation of cross-mode invariance.

The first aspect of the cross-language literature that the current paper has repurposed is within-subject comparison. Repeated administration of the same instrument is an established practise in cross-language research (Sanchez et al., 2005). It allow within-subjects comparison, which robustly controls for a wide range of potentially unknown individual differences that may distort responses in ways that mask genuine cross-language (or cross-mode) differences. The problem of practise effects can be mitigated by counterbalancing the order of administration across participants, and allowing time to pass between administrations. A notable drawback when comparing instruments in this way in cross-language research is the requirement for bilingual individuals, who are often not representative of the population where the translated instrument is to be used. This is not a problem in the cross-mode context. The current study used Chinese-English bilinguals solely because a cross-language translation was used as a comparison point for cross-mode results. Future investigation of cross-mode measurement invariance only requires a sample capable of responding via the modes being compared (and if they are not, the mode under consideration is patently inappropriate).

After repeated within-subjects administrations are conducted, analyses began by comparing self-reported difficulty of completing the instrument in each mode. This is an important indicator of the burden of the participation experience, which impacts on response behaviour and consequently response missingness (Bolger, Davis, & Rafaeli, 2003). If participants find a mode is especially difficult to respond with, it may be inappropriate for use with that instrument, or survey. More subtly, difficulty responding may be associated with disproportionately higher missingness for a particular mode. This is important to keep in mind since differential missingness between modes could bias subsequent statistical comparisons. This was not a problem in the current study, as participant difficulty was generally low, and not associated with response mode.

The next step in analyses was comparison on the level of the whole instrument. Comparison of Cronbach's alpha, total score, and score distribution provide easily interpreted diagnostics of how the different administrations compare. A significant difference in any of these metrics precludes the effort of investigating factor structures, as invariance is clearly violated. Further, as each technique examines a distinct aspect of the instrument, their use in combination can reveal differences that each technique would miss. For example, a researcher may find a significant difference in Cronbach's alpha, but not total score, between modes. Looking at the total score distributions may reveal bimodal peaks for one mode, but a normal distribution for the other. This provides a full picture of how results from the two modes differ. In the current study, Cronbach's alpha, total score, and total score distributions did not significantly differ by mode.

Just as comparison of internal consistency, total score, and score distribution offer complimentary insight into potential sources of differences across modes, so too does the increasingly stringent step-wise nature of multi-group factor analysis can pinpoint the point where administration via two modes may diverge. For example, a researcher finding that two administrations demonstrate configural but not weak invariance can be confident that the number of factors that best explain the instrument does not differ by mode, but conclude there may be subtle mode-based differences in latent means, stemming from item-level differences across modes. The current study found General invariance, cementing the conclusion that administrations of the RTS were not significantly different across either language, or mode.

The current study demonstrated the applicability of cross-language procedure and analysis to cross-mode translation. Here, using a single factor (and consequently constraining analyses to a single factor solution) allowed parsimony in interpretation, and provided conditions conducive to configural invariance (i.e. where cross-loadings are impossible). This reduced the possibility of the weaker forms of invariance precluding examination of the stronger forms, and facilitated examination of each step of factor invariance in a cross-mode context. Doing so has demonstrated the applicability of this approach to examining cross-mode measurement invariance, at least in the case of scales with a single factor. There is no reason to assume its extension to multiple-factor scales should be problematic but future research would directly test this assumption by applying cross-language procedure and analysis to cross-mode translations to instruments with multiple factors.

Research investigating multi-factor instruments will also allow more scope for examining an important, related issue – vulnerability to missingness. Multi-factor instruments tend to be longer, and the longer an instrument, the more scope there is for item skipping and missingness. This is likely because longer instruments are more burdensome to complete, and response burden is associated with poorer response behaviour and disengagement with research (Bolger, Davis, & Rafaeli, 2003). Just like many other statistical procedures, missingness should not pose a problem for the current approach if it is at random, and the sample size is large. In this case, as in the current study, the researcher can simply analyse complete cases. However, it is a problem if missingness is not at random, particularly if it is associated with mode. This may be the case when translating from a mode which provides highly complete data (i.e. by forcing responses or missed response reminders) to one that does not, or vice versa. High levels of mode-based differential missingness could usefully indicate that a mode is unsuitable for a particular instrument or sample, but will also bias the factor analyses used by the current approach to establish measurement invariance. Future research would do well to apply the wide literature discussing how missingness should be detected and dealt with (e.g. the review by Graham, 2009) specifically to the analytical approach discussed in this paper.

The primary aim of this study was to evaluate procedures and analytical techniques, rather than the usefulness of a specific instrument administered in a specific mode. Accordingly, rather than attempting representativeness of the Chinese population, the current study limited the sample to Chinese-English bilinguals in order to reduce noise from the cross-language component of this study, rather than attempting representativeness of the Chinese population. Findings specific to the administration of the RTS in Chinese via SMS have limited generalizability due to the sample, which was chosen on the basis of reducing noise from the cross-language component of this study, rather than attempting representativeness of the Chinese population. However, these findings offer some initial insights into the applicability of SMS as a self-report data collection tool in Chinese, and serve as an example of how the current procedural and analytical approach can be usefully applied in psychological research. Broadly, it is encouraging to demonstrate that an instrument originally developed for pen-and-paper in English can be modified into a very different language, and administered in a very different mode. For researchers seeking to expand the reach of their self-report research in China, it is also promising to show that collecting self-report data via SMS in Chinese is technologically and pragmatically feasible. Future research pursuing the possibility of using SMS to collect self-report data from a rural Chinese population could benefit from following the procedure and techniques outlined in this paper.

Psychological researchers are increasingly turning to administering pre-existing instruments using new modes of data collection, and undertaking multi-modal research (De Beuckelaer & Lievens, 2009; Dillman, Smyth, & Christian, 2009). Though it is important to establish procedures for investigating cross-mode measurement invariance, the literature surrounding the effect of administration mode on the psychometric properties instrument, particularly in cases where an instrument is administered in a mode different from the one it was developed is sparse. This may be due to a lack of a verified structure of procedure and analysis to guide investigation, such as the techniques described in the current paper. In comparison, the conceptually parallel cross-language literature is vast. This study demonstrated how the techniques used in the cross-language literature (repeated within-person administration, and a multi-method analytical approach examining means, distribution shape, and factor invariance) can be successfully applied to investigate cross-mode measurement invariance. The procedure and analyses outlined in the current paper form a useful toolkit for researchers considering using new modes to collect data, or wishing to engage in multi-modal research.

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Walsh, E., Shou, Y., Han, J., & Brinker, J.K.(2015). Translation and validation of a Chinese Language Version of the Ruminative Thought Styles questionnaire. Manuscript submitted for publication.

Yan, X., Gong, M., & Thong, J. Y. L. (2006). Two tales of one service: user acceptance of short message service (SMS) in Hong Kong and China. *Info*, *8*(1), 16–28. doi:10.1108/14636690610643258

Chapter 6: Conclusion

Technological developments have expanded the methodological repertoire available to self-report psychological researchers. There is considerable scope for new modes of data collection to supplement, or in some cases replace, the older standards of postal or online survey. Such methodological innovation is particularly required to facilitate research limited by the sheer difficulty of data collection, such as Ecological Momentary Assessment. Mobile telephones are a clear candidate, as they are ubiquitous, portable, accessible and convenient for both researchers and participants. Mobile phones support three methods of communication that may be used to collect self-report data: voice call, app, and SMS. For reasons of scalability and compatibility with all mobile phones, this dissertation focussed on SMS. This is the first systematic investigation of the strengths and weaknesses of using SMS as a tool for self-report psychological research. It serves as a foundation for future researchers considering whether or not to use SMS as a tool for data collection in their upcoming research, and for further methodologically-focussed investigation of this relatively new research mode.

How is SMS being used for research?

Following in the tradition of methodologically-focussed meta-analyses and structured reviews in the psychological literature (e.g. Cook, Heath, & Thompson, 2000; Fox, Crask, & Kim, 1988; Shih, 2008), this dissertation began by asking ***How is SMS being used for research?*** The intent for doing so was to give context to the ensuing investigation, and highlight knowledge gaps. The wide range of uses for SMS in everyday life was reflected in the answer to this question: **SMS is being used by researchers for a wide range of purposes, but rarely as a tool for self-report data collection**. This meta-analysis also provided relevant information from the use of SMS in other disciplines, for purposes other than self-report. Specifically, the recurrent use of SMS as a reminder (for things such as appointment attendance) suggests that SMS may perform particularly well as a reminder prompt in a self-report research context. Interestingly, the number of studies using SMS for self-report data collection is increasing. This small but growing literature supports the assertion that SMS can be successfully applied as a tool for data collection, and that it is timely to investigate its properties as a research mode in order to guide its future use.

Are people able, ready and willing to become research participants using SMS?

Having established that there is interest among researchers in SMS as a tool for data collection, the next question was ***Are people able, ready and willing to become research participants using SMS?*** The intention was to establish whether there were technological or attitudinal barriers to the use of SMS in a self-report research context, and if so, how they may be surmounted. The answer was that **people are generally able, ready, and willing, but this does not necessarily mean that they will participate in self-report research via SMS.** This dissertation uncovered a decided gap between stated willingness to participate in research via SMS, and actual participation. This 'intention-behaviour gap' has been found in many areas, from weight loss (Sniehotta, Scholz & Schwarzer, 2005) to ethical consumer choices (Carrington, Neville & Whitwell, 2014). As discussed in Sheeran's (2002) meta-analysis of meta-analyses regarding the intention-behaviour gap, there is a low correspondence between intention and behaviour; less than a third of the variance in a wide array of behaviours can be explained by intention. This problem of stated willingness to participate not translating into participation has been discussed in the context of volunteering for research purposes (e.g. Poole, 2012), but not specifically for SMS. The transition from intention to responding may be particularly low for responding to researchers using SMS, because it does not require a participant to go out of their way to respond; they may use the device typically kept nearby in everyday life, rather than having to carry or keep track of a paper diary or digital device, or having to sit at a computer. Future researchers collecting self-report data via SMS could help investigate the behaviour intention gap in SMS participation by exploring potential demographic differences between respondents and non-respondents. If possible, seeking self-reported reasons for response, or non-response, may also be helpful.

How should a researcher design an SMS self-report study?

By the third chapter of this dissertation, a nuanced picture was forming. SMS had successfully been used to collect self-report data in the past, and participants were generally comfortable with the idea of using it to provide self-report data. But, some drawbacks were becoming clear, such as difficulty with participant recruitment. The third question was ***How should a researcher design an SMS self-report study?*** First, this was examined in terms of recruitment, response rates and response behaviour, within the bounds of question length that the literature suggested should be feasible. Then, the limits of SMS were pushed in terms of sampling frequency, and amount of information collected. The answer to the question was was, **By extensive pilot-testing with a focus on the following methodological issues: minimisation of the time lag between recruitment and participation, the sampling frequency, the sampling tempo (hourly, daily, weekly etc.), the number of questions, and the length of meaningful responses.** Despite the attractiveness of a simple checklist of optimal conditions for using SMS to support research (e.g. "SMS should not ask more than X questions at a time", or

"Researchers should expect a Y minute response delay"), the interdependency of the discussed methodological decisions precludes a simple set of guidelines. Rather, these results provide general principles (e.g. minimising delay between recruitment and active participation, keeping the measure short, and making use of the capacity for frequent sampling), and highlight the importance of deliberate consideration of how a methodology may be used in specific research contexts.

How does SMS compare with other tools for data collection?

By the fourth chapter, it seemed clear that SMS could be used for self-report data collection, but just because you *can* do something, does not mean that you *should.* With online and paper surveys, self-report research in general already has a well-established methodological repertoire. Although Ecological Momentary Assessment could certainly benefit from a new data collection method, SMS is not necessarily the best option for data collection. The final question was therefore ***How does SMS compare with other tools for data collection?*** Anticlimactically, the answer was **SMS can compare favourably, or unfavourably to other modes depending on you want from a data collection tool**. The findings suggest that if a researcher wants a data collection tool that provides timely responses and high response rates, and is sampling once or over the course of a day, SMS holds its own with or even outperforms other modes like apps, email, postal and online surveys. But, if a researcher is more interested in response completeness than response rates, or is sampling over a longer time period, SMS compares poorly to other modes on almost every metric.

Future directions and limitations

The limitations of each study within this dissertation have been discussed in their respective papers, but when viewed as a whole, one emergent issue bears discussion. This dissertation consisted of fifteen separate papers that each examined SMS as a tool for data collection in a different way. The choice to cast a wide net, rather than focus on a single narrow issue, developed as the literature revealed an extensive range of ways SMS could be used to support research. The particular factors investigated were carefully chosen based on what the early chapters indicated may be important (i.e. how to minimise participant drop-out following recruitment), choices relevant to experience sampling methods (i.e. sampling timing and frequency), and choices specific to the most salient properties of SMS, such as the strict character limit (i.e. questionnaire and response length). This broad approach has allowed advancement in understanding a number of the methodological properties of SMS, but also leaves considerable scope for more detailed investigation of each of the factors discussed.

Another issue that bears discussion is the impact of the explicit methodological focus of the research on the ecological validity of many of the studies presented here. With the exception of *Delay between recruitment and participation impacts on pre-inclusion attrition* (Chapter 4), the information provided to participants in studies involving data collection via SMS (Chapters 4 and 5) clearly stated the duel theoretical and methodological aims of each study. A typical example of this are the following excerpts from the information sheet for *Applying cross-language principles to measuring cross-mode language invariance* (Chapter 5).

> This research project is examining rumination, measuring it across multiple languages and using different techniques such as online surveys, paper surveys, and surveys sent via text message (SMS).

Why might I be asked to complete the measure by SMS, online survey or paper responses?

Erin's PhD is about investigating the usefulness of text messaging as a tool for research. By completing this research either by email, online survey, on paper or by SMS you will help me uncover how using different research tools might impact people's responses. You may be asked to do the same questionnaire twice, but using different modes. This is so I can compare different the modes. Knowing this, you may feel compelled to answer in a certain way to try to be helpful. Please answer as naturally and honestly as possible.

In this way, participants were informed about both the theoretical and methodological hypotheses of the research. This may threaten the generalisability of these findings beyond methodologically focussed research due to social desirability effects. Knowing that SMS is the focus of the researcher, participants may have inflated the effort put in to responding via SMS in a misguided attempt to please the researcher. This could have resulted in systematic overestimation of the data quality that SMS provides across several studies. At this point, it is important to draw a distinction between the potential effect of sending SMS in the context of research in general, and the effect of sending SMS in the context of *methodologically-focused research.* It is not at all a problem if the use of SMS in a research context in encourages more detailed and comprehensive responses in comparison to everyday usage (as may have been the case in *Short and Sweet? Length and informativeness content of open-ended responses using SMS as a research mode*). This may be a rare example of a social desirability bias that benefits the researcher, and would be present across all studies using SMS to collect data. But, it is a problem if the methodological focus of research causes participants to respond in ways that they would not in research that happens to use SMS. This could be investigated further by conducting further data collection via SMS, and manipulating whether or no participants are told the research has a methodological focus.

Returning to the current studies, the potential for this to bias results was mitigated somewhat by an emphasis that the studies within this dissertation are exploratory research, and that the researcher was not at all invested in whether SMS was a particularly good or bad tool for data collection. The aim was always phrased around 'investigating the properties of SMS' rather than 'proving the strengths of SMS'. Another approach could have been the use of a cover story or deception to hide the methodological elements of the research from participants. But this proved difficult in in pilot testing, where participants were invariably curious about why they were being asked to respond in SMS, as the bulk of them (notably the university student populations) only had experience with paper or online surveys. When it came time to seek ethics approval for studies involving data collected via SMS, keeping the rationale behind using SMS from participants would have constituted deception. The ANU Human Research Committee pointed out that such use of deception may have threatened recruitment (as failure to justify methodology could give the impression of poorly constructed research), and were unconvinced that preserving ecological validity was sufficient grounds for deception. This view was supported by studies in Chapter 3, in particular *Perceived Legitimacy of SMS as a psychological research mode*, which found that the perceived appropriateness of a research mode, particularly in the context of other modes that could be used, is an important factor in intention to participate. Because SMS ranks poorly against the legitimacy of other research modes, this supports the need to be upfront and justify the use of SMS when recruiting participants. Due to the lack of pre-existing literature to justify the use of

SMS to participants, the only cogent rationale is the actual purpose of the research, the investigation of its performance as a research mode.

One area this dissertation did not discuss was the performance of SMS when used for event-contingent sampling, where participants respond whenever the thought, feeling, or behaviour of interest occurs (Christensen et.al., 2003). This is different from signal-contingent sampling, where participants respond to a prompt sent by the researcher. With different strengths and weaknesses, both are widely used in experience sampling literature (Reis & Gable, 2000). The frequency of 'events' reported in event-contingent sampling can be an informative indicator of a participant's experience (e.g. in Ebner-Priemer, Eid, Kleindienst, Stabenow, & Trull, 2009). Alternately, signal-contingent sampling allows the researcher to set a known response schedule rather than relying on likely changeable event-related response schedules. Only signal-contingent sampling was explored in this dissertation, as having a known response schedule is vital for investigating deviations from the desired schedule (e.g. response delays, number of missing responses), and for exploring issues of sampling frequency (e.g. feasibility of sampling a certain number of times in a given day). This choice helped to uncover the general methodological properties of SMS for collecting self-report data, but neglected the properties of SMS when used in an event-contingent design. Given that SMS prompts can substantially improve response behaviour (outlined in chapters 4 and 5), it is possible that SMS may perform poorly in an event-contingent context where prompts are not sent. Alternatively, SMS may perform very well for event-contingent sampling as participants are likely to keep their mobile telephone nearby, as opposed to problems with forgetting or misplacing paper diaries. Future research would do well to specifically investigate the properties of SMS as a tool for event-contingent self-report research.

Another avenue future research could pursue is the application of SMS to collect data from rural or remote areas. This dissertation focussed on an urban population, sampling primarily in Canberra, the capital city of Australia. Mobile telephones are increasingly providing communication lines to rural areas which were previously unreachable due to the difficulty in installing physical telecommunication infrastructure (Lacohée, Wakeford, & Pearson, 2003). Accordingly, there is particular interest in using SMS for communicating with people living in rural areas (e.g. Githinji et al., 2014; Kamanga, Moono, Stresman, Mharakurwa, & Shiff, 2010; Lori, Munro, Boyd, & Andreatta, 2012). As the technological and social context often differs between city and rural areas (Hindman, 2000), it would be informative to establish whether the properties of SMS as a tool for research in a city sample can guide expectations of its performance with a rural sample.

Differences in everyday SMS usage and language may limit the generalisability of the current research to other countries. Countries differ in terms of in SMS history, availability, usage, culture, and language (Busse, & Fuchs, 2012; Latham, 2007). These differences may be important, because as several papers in Chapter 3 demonstrated, behaviours, perceptions and attitudes toward SMS in everyday life are associated with how people view SMS in a research context. For example, in Germany, SMS usage is accompanied by a strong culture of reciprocity – if someone receives an SMS, they are highly likely to respond (Hoflich & Rossler, 2002). In a research context, this may translate into particularly high response rates when communicating with German participants via SMS. In China, SMS has become an important tool for confidential political communication between citizens, because it is less susceptible to strict government monitoring and censorship than other text-based communication methods (Yan, 2003; Yu, 2004). In a research context, this perception of security and privacy may make SMS a particularly viable tool for collecting self-report data on sensitive topics in China. The physical properties of the written language may impact on how much information can be conveyed in an SMS (Carrier & Benitez, 2010). Accordingly, expectations about the feasible length of questions and response may need to be modified – in comparison to an English sentence, the German equivalent would require more characters, and the Chinese equivalent far fewer. There is considerable scope for future research to examine whether considerations such as these impact on how SMS may be used to collect self-report data in different countries.

Conclusions

Together, the fifteen papers that make up this dissertation have been successful in uncovering some useful guidelines for future research which may use SMS. In summary, the strengths of SMS as a tool for self-report psychological research included growing interest in research community; positive perceptions of SMS as a research tool amongst potential samples; swift responses and high response rate; suitability for frequent repeated sampling; and usefulness as a reminder prompt to support other modes of data collection. Weaknesses included a large difference between stated willingness to participate and actual participation; response incompleteness; unsuitability for infrequent sampling; and problems with psychometric equivalence in relation to other research modes like online or paper surveys.

SMS constitutes a largely unused, but potentially powerful, tool for self-report data collection. The research within this dissertation paints a picture of a research mode that participants are able and willing to use, and that is particularly well suited to short bouts of high-frequency sampling. Against the backdrop of other research modes available for self-report data collection, SMS provides comparatively high response rates, but also comparatively low response completeness. Nonetheless, SMS is capable of providing robust and valid information at sampling frequencies that other modes, such as online or paper surveys, may struggle to match. The bidirectional nature of communication between researcher and participant opens up avenues for ongoing data monitoring and question clarification impossible in other modes, such as paper surveys (which are generally fixed once printed). Perhaps most importantly, SMS is ideally suited to bolstering a vitally important, but difficult form of research: Ecological Momentary Assessment.

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Carrington, M. J., Neville, B. A., & Whitwell, G. J. (2014). Lost in translation: Exploring the ethical consumer intention–behavior gap. Journal of Business Research, 67(1), 2759-2767

Christensen, T. C., Barrett, L. F., Bliss-Moreau, E., Lebo, K., & Kaschub, C. (2003). A practical guide to experience-sampling procedures. Journal of Happiness Studies, 4(1), 53-78.

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Hindman, D. B. (2000). The rural-urban digital divide. Journalism & Mass Communication Quarterly, 77(3), 549-560.

Hoflich, J. R., & Rossler, P. (2002). More than just a telephone: The mobile phone and use of the short message service (SMS) by German adolescents, results of a pilot study. In E. A. Villar (Ed.), *Revista de Estudios de Juventud* (pp. 61–64).

Kamanga, A., Moono, P., Stresman, G., Mharakurwa, S., & Shiff, C. (2010). Rural health centres, communities and malaria case detection in Zambia using mobile telephones: a means to detect potential reservoirs of infection in unstable transmission conditions. *Malaria Journal*, *9*, 96. http://doi.org/10.1186/1475-2875-9-96

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Lori, J. R., Munro, M. L., Boyd, C. J., & Andreatta, P. (2012). Cell phones to collect pregnancy data from remote areas in Liberia. *Journal of Nursing Scholarship : An Official Publication of Sigma Theta Tau International Honor Society of Nursing / Sigma Theta Tau*, *44*(3), 294–301. http://doi.org/10.1111/j.1547-5069.2012.01451.x

Poole, G. (2012). Using psychological principles to narrow the intention-behavior gap and increase participation in HIV vaccine trials. Current HIV research, 10(6), 552-556.

Reis, H. T., & Gable, S. L. (2000). Event-sampling and other methods for studying everyday experience. Handbook of research methods in social and personality psychology, 190-222.

Sheeran, P. (2002). Intention—behavior relations: A conceptual and empirical review. European review of social psychology, 12(1), 1-36.

Shih, T.H. (2008). Comparing Response Rates from Web and Mail Surveys: A Meta-Analysis. *Field Methods*, *20*(3), 249–271. http://doi.org/10.1177/1525822X08317085

Sniehotta, F. F., Scholz, U., & Schwarzer, R. (2005). Bridging the intention–behaviour gap: Planning, self-efficacy, and action control in the adoption and maintenance of physical exercise. Psychology & Health, 20(2), 143-160.

Yan, X. (2003). Mobile Data Communications in China. *Communications of the ACM*, *46*(12), 81 – 85.

Yu, H. (2004). The power of thumbs: the politics of SMS in urban china. *Graduate Journal of Asia-Pacific Studies*, *2*(2), 30–43.

Appendix 1: Ethical approvals

The ethical aspects of the research conducted for this thesis were approved by the Australian National University Human Research Ethics Committee. Protocol numbers and project titles are as follows.

2012/054: *Investigating cognition in context: Ambulatory assessment of mental time travel.*

2012/079: *Response Validity in a self-report SMS framework.*

2012/357: *The impact of time between recruitment and participation on response rate in an SMS methodology.*

2012/475: *Establishing the optimum and maximum survey lengths for use with an SMS methodology*

2013/101: *SMS4Deaf – SMS as a tool for psychological research with the deaf*

2013/193: *The use of SMS as a tool for cross-language research*

2013/353: *Using repeated SMS and reported archival phone data to map attachment hierarchies*

2013/370: *Application of the Unified Theory of Acceptance and Use of Technology model to the use of SMS for psychological research*

Appendix 2: Meta-Analysis Tables (Chapter 2)

Appendix 2 Table 1. *Constituent papers for the preliminary category.*

Paper	Focus
Ahlers-Schmidt, C. R., Chesser, A. K., Nguyen, T., Brannon, J., Hart, T., Williams, K. S., & Wittler, R. R. (2012). Feasibility of a randomized controlled trial to evaluate Text Reminders for Immunization Compliance in Kids (TRICKs). *Vaccine, 30*(36), 5305–9. doi:10.1016/j.vaccine.2012.06.058	Health
Ahlers-schmidt, C. R., Chesser, A., Hart, T., Paschal, A., Nguyen, T., & Wittler, R. R. (2010). Text messaging immunization reminders: Feasibility of implementation with low-income parents. *Preventive Medicine, 50*(5), 306–307. doi:10.1016/j.ypmed.2010.02.008	Health
Ahlers-Schmidt, C. R., Jones, J. T., Chesser, A., & Weeks, K. (2013). Evaluating opportunities for text message communication: a survey of parents and teens. *Telemedicine journal and e-health, 19*(9), 711–3. doi:10.1089/tmj.2012.0270	Health
Akamatsu, C. T., Mayer, C., & Farrelly, S. (2006). An investigation of two-way text messaging use with deaf students at the secondary level. *Journal of deaf studies and deaf education, 11*(1), 120–31. doi:10.1093/deafed/enj013	Health
Andrews, L., Cacho-Elizondo, S., Drennan, J., & Tossan, V. (2013). Consumer acceptance of an SMS-assisted smoking cessation intervention: a multicountry study. *Health marketing quarterly, 30*(1), 47–62. doi:10.1080/07359683.2013.758015	Health
Bachmann, S., Ruddies, C., Kordy, H., & Bauer, S. (2008). SMS in the outpatient treatment of schizophrenia: feasibility and acceptance. *European Psychiatry* (23), 101–102.	Psych
Barclay, E. (2009). Text messages could hasten tuberculosis drug compliance. *The Lancet*, 373(9657), 15–16. doi:10.1016/S0140-6736(08)61938-8	Health
Barlott, T. (2013). *The experience of caregivers of people with disabilities in a project that used SMS as a tool to improve information access and social interaction in an under-resourced colombian community.* University of Alberta, United States of America.	Health
Bartley, A., Rivet, W. K., Bova, C., & Womack, J. A. (2013). A Proposal for Quality Standards for Measuring Medication Adherence in Research. *AIDS and Behavior, 17*(1), 284–297. doi:10.1007/s10461-012-0172-7	Health
Bock, B. C., Heron, K. E., Jennings, E. G., Magee, J. C., & Morrow, K. M. (2013). User preferences for a text message-based smoking cessation intervention. *Health education and behavior, 40*(2), 152–9. doi:10.1177/1090198112463020	Health
Bogart, K., Wong, S. K., Lewis, C., Akenzua, A., Hayes, D., Prountzos, A., ... & Kravariti, E. (2014). Mobile phone text message reminders of antipsychotic medication: is it time and who should receive them? A cross-sectional trust-wide survey of psychiatric inpatients. *BMC psychiatry, 14*(1), 15. doi:10.1186/1471-244X-14-15	Psych
Buchholz, S. W., Ingram, D., Wilbur, J., & Pelt, P. (2013). Using photos to develop text messages to promote walking. *Journal of nursing scholarship, 45*(4), 380–7. doi:10.1111/jnu.12043	Health
Cormick, G., Kim, N. A., Rodgers, A., Gibbons, L., Buekens, P. M., Belizán, J. M., & Althabe, F. (2012). Interest of pregnant women in the use of SMS (short message service) text messages for the improvement of perinatal and postnatal care. *Reproductive health, 9*(9), 1–7. doi:10.1186/1742-4755-9-9	Health
Cornelius, J. B., St Lawrence, J. S., Howard, J. C., Shah, D., Mcdonald, D., & White, A. C. (2013). Adolescents' perceptions of a mobile cell phone text messaging-enhanced intervention and development of a mobile cell phone-based HIV prevention intervention. *Journal for Specialists in Pediatric Nursing, 17*(1), 61–69. doi:10.1111/j.1744-6155.2011.00308.x.Adolescents	Health
Cuilla, M. M., Meazza, R., Giagnoni, P., Vecchiato, C., Aquistapace, G., Benenati, C., Nicolini, P., et al. (2011). "SMS Therapy": a new approach to increasing compliance to antihypertensive treatment. *Journal of hypertension,* 29, e458.	Health
Curioso, W. H., Alex Quistberg, D., Cabello, R., Gozzer, E., Garcia, P. J., Holmes, K. K., & Kurth, A. E. (2009). "It's time for your life": How should we remind patients to take medicines using short text messages? Annual	Health

Symposium proceedings. AMIA Symposium, 2009, 129–33. Retrieved from http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=3105604

Curran, K. G. (2013). New approaches to HIV prevention in African HIV serodiscordant couples: antiretrovirals and mobile technology. (Doctoral dissertation). Health

Dang, C. M., Estrada, S., Bresee, C., & Phillips, E. H. (2013). Exploring Potential Use of Internet, E-mail, and Instant Text Messaging to Promote Breast Health and Mammogram Use among Immigrant Hispanic Women in Los Angeles County. *American Surgeon, 79*(10), 997 – 1000. Health

Davi, M., & Stecke, A. (2011). Pediatric Obesity and Short Message System (SMS) Messaging for Behavioral Change. *Journal of Pediatric Health Care, 25*(5), e23. doi:10.1016/j.pedhc.2011.06.013 Health

De Keizer, L., Chow, C., Jacobs, M., Thiagalingam, & Redfern, J. (2013). Acceptability and Utility of a Text Message-based Intervention for the Secondary Prevention of Cardiovascular Disease (CVD). *Heart, Lung and Circulation,* 22, S258. doi:10.1016/j.hlc.2013.05.616 Health

Epstein, J., & Bequette, A. W. (2013). Smart Phone Applications in Clinical Practice. *Journal of Mental Health Counseling, 35*(4), 283-295. Psych

Fjeldsoe, B. S., Miller, Y. D., Brien, J. L. O., & Marshall, A. L. (2012). Iterative development of MobileMums: a physical activity intervention for women with young children. *International Journal of Behavioral Nutrition and Physical Activity, 9*(1), 1. doi:10.1186/1479-5868-9-151 Health

Gatwood, J., Balkrishnan, R., Erickson, S. R., An, L. C., Piette, J. D., & Farris, K. B. (2014). Addressing medication nonadherence by mobile phone: development and delivery of tailored messages. *Research in Social and Administrative Pharmacy, 10*(6), 809-823. doi:10.1016/j.sapharm.2014.01.002 Health

Giorgio, M. M., Kantor, L. M., Levine, D. S., & Arons, W. (2013). Using chat and text technologies to answer sexual and reproductive health questions: planned parenthood pilot study. *Journal of medical Internet research, 15*(9), e203. doi:10.2196/jmir.2619 Health

Gold, J., Lim, M. S. C., Hellard, M. E., Hocking, J. S., & Keogh, L. (2010). What's in a message? Delivering sexual health promotion to young people in Australia via text messaging. *BMC public health, 10*(1), 792. doi:10.1186/1471-2458-10-792 Health

Gonzales, R., Douglas Anglin, M., & Glik, D. C. (2014). Exploring the feasibility of text messaging to support substance abuse recovery among youth in treatment. *Health education research, 29*(1), 13–22. doi:10.1093/her/cyt094 Health

Hart, T., Ahlers-Schmidt, C. R., Chesser, A., Jones, J., Williams, K. S., & Wittler, R. R. (2011). Physician impressions of using text message technology to increase vaccination compliance. *Telemedicine journal and e-health, 17*(6), 427–30. doi:10.1089/tmj.2010.0221 Health

Hingle, M., Nichter, M., Medeiros, M., & Grace, S. (2013). Texting for health: the use of participatory methods to develop healthy lifestyle messages for teens. *Journal of nutrition education and behavior, 45*(1), 12–9. doi:10.1016/j.jneb.2012.05.001 Health

Hofstetter, A. M., Vargas, C. Y., Kennedy, A., Kitayama, K., & Stockwell, M. S. (2013). Parental and provider preferences and concerns regarding text message reminder/recall for early childhood vaccinations. *Preventive medicine, 57*(2), 75–80. doi:10.1016/j.ypmed.2013.04.007 Health

Hughes, L. D., Done, J., & Young, A. (2011). Not 2 old 2 TXT: there is potential to use email and SMS text message healthcare reminders for rheumatology patients up to 65 years old. *Health informatics journal, 17*(4), 266–76. doi:10.1177/1460458211422019 Health

Jennings, L., Ong'ech, J., Simiyu, R., Sirengo, M., & Kassaye, S. (2013). Exploring the use of mobile phone technology for the enhancement of the prevention of mother-to-child transmission of HIV program in Nyanza, Kenya: a qualitative study. *BMC public health, 13*, 1131. doi:10.1186/1471-2458-13-1131 Health

Keller, A. M. (2013). *Mobile Phones and Health Communication for Young Adults: An exploratory Case study about incorporating text messaging into pregnancy care support in Edmonton.* Edmonton university, United States of America. Health

Kelley, H., Chiasson, M., Downey, A., & Pacaud, D. (2011). The Clinical Impact of eHealth on the Self-Management of Diabetes: A Double Adoption Perspective. *Journal of the association for information systems, 12*, 208–234. Health

Kharbanda, E. O., Stockwell, M. S., Fox, H. W., & Rickert, V. I. (2009). Text 4 health: a qualitative evaluation of parental readiness for text message immunization reminders. *American journal of public health, 99* (23), 2176 – 2178. doi:10.2105/AJPH.2009.161364 (two studies)	Health
Khosropour, C. M., Lake, J. G., & Sullivan, P. S. (2013). Are MSM Willing to SMS for HIV Prevention? *Journal of health communication: international perspectives, 19*(1), 37–41. doi:10.1080/10810730.2013.798373	Health
Kim, J. Y., Lee, K. H., Kim, S. H., Kim, K. H., Kim, J. H., Han, J. S., Bang, S. S., et al. (2013). Needs analysis and development of a tailored mobile message program linked with electronic health records for weight reduction. *International journal of medical informatics, 82*(11), 1123–32. doi:10.1016/j.ijmedinf.2013.08.004	Health
King, T., Tomaszewski, K., Persing, N., Arrington-Sanders, R., Land, C., & Willcox, M. (2014). Do Adolescents Want Their Parents to Receive Text Message Reminders for Their Appointments? *Journal of Adolescent Health, 54*(2), S31–S32. doi:10.1016/j.jadohealth.2013.10.076	Health
Kinyua, F., Kiptoo, M., Kikuvi, G., Mutai, J., Meyers, A. F. a, Muiruri, P., & Songok, E. (2013). Perceptions of HIV infected patients on the use of cell phone as a tool to support their antiretroviral adherence; a cross-sectional study in a large referral hospital in Kenya. *BMC public health, 13*(1), 987. doi:10.1186/1471-2458-13-987	Health
Kool, B., Smith, E., Raerino, K., & Ameratunga, S. (2014). Perceptions of adult trauma patients on the acceptability of text messaging as an aid to reduce harmful drinking behaviours. *BMC research notes, 7*, 4. doi:10.1186/1756-0500-7-4	Psych
La Rue, E. M., Li, Y., Karimi, H. a., & Mitchell, A. M. (2012). A Description of the Development and Architecture of an SMS-Based System for Dealing With Depression. *Procedia Technology, 5*, 670–678. doi:10.1016/j.protcy.2012.09.074	Psych
Lei, X., Liu, Q., Wang, H., Tang, X., Li, L., & Wang, Y. (2013). Is the short messaging service feasible to improve adherence to tuberculosis care? A cross-sectional study. *Transactions of the Royal Society of Tropical Medicine and Hygiene, 107*(10), 666–8. doi:10.1093/trstmh/trt070	Health
Lester, R., & Karanja, S. (2008). Mobile phones: exceptional tools for HIV/AIDS, health, and crisis management. *The Lancet infectious diseases, 8*(12), 738–9. doi:10.1016/S1473-3099(08)70265-2	Health
Li, S., Zhu, W., Park, S.-H., & Lin, J. (2008). Monitoring Glucose and Physical Activity Using Mobile Phone: A Proposed System. *Medicine and Science in Sports and Exercise* (40), 427 – 428. doi:10.1249/01.mss.0000322821.83961.1d	Health
Liu, L., Du, X., Li, Y., & Car, J. (2013). mHealth Series?: Measuring maternal newborn and child health coverage by text messaging. *Journal of global health, 3*(2), 1 – 8. doi:10.7189/jogh.03.020402	Health
Mall, S., Sibeko, G., Temmingh, H., Stein, D. J., Milligan, P., & Lund, C. (2013). Using a treatment partner and text messaging to improve adherence to psychotropic medication: a qualitative formative study of service users and caregivers in Cape Town, South Africa. *African journal of psychiatry, 16*(5), 364–70. doi:http://dx.doi.org/10.4314/ajpsy.v16i5.49	Psych
Mitchell, K. J., Bull, S., Kiwanuka, J., & Ybarra, M. L. (2011). Cell phone usage among adolescents in Uganda: acceptability for relaying health information. *Health education research, 26*(5), 770–81. doi:10.1093/her/cyr022	Health
Mojica, C. M., Parra-Medina, D., Yin, Z., Akopian, D., & Esparza, L. (2013). Assessing Media Access and Use Among Latina Adolescents to Inform Development of a Physical Activity Promotion Intervention Incorporating Text Messaging. *Health promotion practice*. doi:10.1177/1524839913514441	Health
Muench, F., Weiss, R. A., Kuerbis, A., & Morgenstern, J. (2013). Developing a Theory Driven Text Messaging Intervention for Addiction Care With User Driven Content. *Psychology of addictive behaviors, 27*(1), 315–321. doi:10.1037/a0029963	Health
Naughton, F., Jamison, J., & Sutton, S. (2013). Attitudes towards SMS text message smoking cessation support: a qualitative study of pregnant smokers. *Health education research, 28*(5), 911–22. doi:10.1093/her/cyt057	Health
Neville, R. G. (2008). Early experience of the use of short message service (SMS) technology in routine clinical care. *Informatics in Primary care, 16*, 203–211.	Health
Otieno, G., Githinji, S., Jones, C., Snow, R. W., Talisuna, A., & Zurovac, D. (2014). The feasibility, patterns of use and acceptability of using mobile phone text-messaging to improve treatment adherence and post-treatment review of children with uncomplicated malaria in western Kenya. *Malaria journal, 13*(1), 44. doi:10.1186/1475-2875-13-44	Health

Person, A. K., Blain, M. L. M., Jiang, H., Rasmussen, P. W., & Stout, J. E. (2011). Text messaging for enhancement of testing and treatment for tuberculosis, human immunodeficiency virus, and syphilis: a survey of attitudes toward cellular phones and healthcare. *Telemedicine journal and e-health, 17*(3), 189–95. doi:10.1089/tmj.2010.0164 Health

Pinnock, H., Slack, R., Pagliari, C., Price, D., & Sheikh, A. (2006). Exploring professional and patient attitudes to mobile telephone-based technologies for monitoring asthma: Qualitative study. *Primary Care Respiratory Journal, 15*(3), 196–196. doi:10.1016/j.pcrj.2006.04.137 (two studies) Health

Priyaa, S., Murthy, S., Sharan, S., Mohan, K., & Joshi, A. (2013). A pilot study to assess perceptions of using SMS as a medium for health information in a rural setting. *Technology and Health Care, 22*(1), 1-11. Health

Ranney, M. L., Choo, E. K., Cunningham, R. M., Spirito, A., Thorsen, M., Mello, M. J., & Morrow, K. (2014). Acceptability, language, and structure of text message-based behavioral interventions for high-risk adolescent females: A qualitative study. *Journal of Adolescent Health, 55*(1), 33-40. doi:10.1016/j.jadohealth.2013.12.017 Psych

Raymond, C. W. P., Kayekjian, K. C., Braun, R. A., Cantu, M., Sheoran, B., & Chung, P. J. (2012). Adolescents' Perspectives on the Use of a Text Messaging Service for Preventive Sexual Health Promotion. *Journal of adolescent health, 51*(3), 220–225. doi:10.1016/j.jadohealth.2011.11.012 Health

Reid, M. J. A., Dhar, S. I., Carey, M., Liang, P., Thompson, J., Gabaitiri, L., Steele, K., et al. (2013). Opinions and attitudes of participants in a randomized controlled trial examining the efficacy of SMS reminders to enhance antiretroviral adherence: a cross-sectional survey. *JAIDS Journal of Acquired Immune Deficiency Syndromes,* 65(2), 86 – 88. Health

Reynolds, V. (2013). *Listening to Adolescents about Text Messaging in Sexual Health*. The University of Manitoba, the United States of America. Health

Sanghara, H., Kravariti, E., Jakobsen, H., & Okocha, C. (2010). Using short message services in mental health services: assessing feasibility. *Mental Health Review Journal, 15*(2), 28 – 33. doi:10.5042/mhrj.2010.0369 Psych

Sankaranarayanan, J., & Sallach, R. E. (2014). Rural patients' access to mobile phones and willingness to receive mobile phone-based pharmacy and other health technology services: a pilot study. *Telemedicine journal and e-health, 20*(2), 182–5. doi:10.1089/tmj.2013.0150 Health

Selkie, E. M., Benson, M., & Moreno, M. (2012). Adolescents' views regarding uses of social networking websites and text messaging for adolescent sexual health education. *American Journal of Health Education, 42*(4), 205–212. doi:10.1080/19325037.2011.10599189 Health

Sharifi, M., Dryden, E. M., Horan, C. M., Price, S., Marshall, R., Hacker, K., Finkelstein, J. a, et al. (2013). Leveraging text messaging and mobile technology to support pediatric obesity-related behavior change: a qualitative study using parent focus groups and interviews. *Journal of medical Internet research, 15*(12), e272. doi:10.2196/jmir.2780 Health

Siedner, M. J., Haberer, J. E., Bwana, M. B., Ware, N. C., & Bangsberg, D. R. (2012). High acceptability for cell phone text messages to improve communication of laboratory results with HIV-infected patients in rural Uganda: a cross-sectional survey study. *BMC medical informatics and decision making, 12*(1), 56. doi:10.1186/1472-6947-12-56 Health

Stenner, S. P., Johnson, K. B., & Denny, J. C. (2012). PASTE: patient-centered SMS text tagging in a medication management system. *Journal of the American Medical Informatics Association, 19*(3), 368–74. doi:10.1136/amiajnl-2011-000484 Health

Suffoletto, Brian, Callaway, C. W., Kristan, J., Monti, P., & Clark, D. B. (2013). Mobile phone text message intervention to reduce binge drinking among young adults: study protocol for a randomized controlled trial. *Trials, 14*(1), 93. doi:10.1186/1745-6215-14-93 Health

Sutton, S., Smith, S., Jamison, J., Boase, S., Mason, D., Prevost, T., Brimicombe, J., et al. (2013). Study protocol for iQuit in Practice: a randomised controlled trial to assess the feasibility, acceptability and effectiveness of tailored web- and text-based facilitation of smoking cessation in primary care. *BMC public health, 13*, 324. doi:10.1186/1471-2458-13-324 Health

Suwamaru, J. K. (2012). An SMS-based HIV / AIDS Education and Awareness Model for Rural Areas in Papua New Guinea. Global telehealth, *Stud Health Technol Inform, 182,* 161 – 169. doi:10.3233/978-1-61499-152-6-161 Health

Te Boveldt, N., Engels, Y., Besse, K., Vissers, K., & Vernooij-Dassen, M. (2011). Rationale, design, and implementation protocol of the Dutch clinical practice guideline pain in patients with cancer: a cluster randomised Health

controlled trial with Short Message Service (SMS) and Interactive Voice Response (IVR). *Implementation science, 6*(1), 126. doi:10.1186/1748-5908-6-126	
Tripathi, A., Duffus, W. A., Kissinger, P., Brown, T. J., Gibson, J. J., & Mena, L. A. (2011). Delivering Laboratory Results by Text Message and E-Mail: A Survey of Factors Associated with Conceptual Acceptability Among STD Clinic Attendees. *Telemedicine and e-Health,* 18(7), 500–506. doi:10.1089/tmj.2011.0251	Health
Van der Kop, Mia L, Ojakaa, D. I., Patel, A., Thabane, L., Kinagwi, K., Ekström, A. M., Smillie, K., et al. (2013). The effect of weekly short message service communication on patient retention in care in the first year after HIV diagnosis: study protocol for a randomised controlled trial (WelTel Retain). *BMJ Open,* 3, e003155. doi:10.1136/bmjopen-2013-003155	Health
Van Heerden, A. C., Norris, S. a, & Richter, L. M. (2010). Using mobile phones for adolescent research in low and middle income countries: preliminary findings from the birth to twenty cohort, South Africa. *The Journal of adolescent health, 46*(3), 302–4. doi:10.1016/j.jadohealth.2009.09.008	Health
Vyas, A. N., Landry, M., Schnider, M., Rojas, A. M., & Susan, F. (2012). Public Health Interventions: Reaching Latino Adolescents via Short Message Service and Social Media. *Journal of medical internet research, 14*(4), e99. doi:10.2196/jmir.2178	Health
Wangberg, S. C., Gammon, D., & Spitznogle, K. (2007). In the Eyes of the Beholder? Exploring Psychologists' Attitudes towards and Use of e-Therapy in Norway. *CyberPsychology and behavior, 10*(3), 418–423. doi:10.1089/cpb.2006.9937	Psych
Woolford, S. J., Barr, K. L. C., Derry, H. A., Jepson, C. M., Clark, S. J., Strecher, V. J., & Resnicow, K. (2009). OMG do Not Say LOL: Obese Adolescents' Perspectives on the content of Text Messages to Enhance Weight Loss Efforts. *Obesity, 19*(12), 2382–2387. doi:10.1038/oby.2011.266	Health
Xiao, Y., Ji, G., Tian, C., Li, H., Biao, W., & Hu, Z. (2013). AIDS Care: Psychological and Socio-medical Aspects of AIDS / HIV Acceptability and factors associated with willingness to receive short messages for improving antiretroviral therapy adherence in China. *AIDS Care, 00*(00), 1–7. doi:10.1080/09540121.2013.869540	Health
Zurovac, D., Larson, B. A., Sudoi, R. K., & Snow, R. W. (2012). Costs and Cost-Effectiveness of a Mobile Phone Text- Message Reminder Programmes to Improve Health Workers ' Adherence to Malaria Guidelines in Kenya. *PLoS ONE, 7*(12). doi:10.1371/journal.pone.0052045	Health

Note. Papers containing multiple studies are identified after the citation.

Appendix 2 Table 2. *Constituent papers for the reviews category.*

Paper	Focus	General target
Abebe, N., Capozza, K. L., Des Jardins, T. R., Kulick, D. a, Rein, A. L., Schachter, A. a, & Turske, S. a. (2013). Considerations for community-based mHealth initiatives: insights from three Beacon Communities. *Journal of medical Internet research, 15*(10), e221. doi:10.2196/jmir.2803	Health	Mobile
Aggarwal, N. K. (2012). Applying mobile technologies to mental health service delivery in South Asia. *Asian journal of psychiatry, 5*(3), 225–30. doi:10.1016/j.ajp.2011.12.009	Psych	Mobile
Bärnighausen, T., Chaiyachati, K., Chimbindi, N., Peoples, A., Haberer, J., & Newell, M.-L. (2011). Interventions to increase antiretroviral adherence in sub-Saharan Africa: a systematic review of evaluation studies. *The Lancet infectious diseases, 11*(12), 942–51. doi:10.1016/S1473-3099(11)70181-5	Health	Topic
Baxter, R. J., & Hunton, J. E. (2011). Capturing affect via the experience sampling method: Prospects for accounting information systems researchers. *International Journal of Accounting Information Systems, 12*(2), 90–98. doi:10.1016/j.accinf.2010.12.002	Psych	Topic
Blake, H. (2008). Mobile phone technology in chronic disease management. *Nursing, 23*(12), 43–6. doi:10.7748/ns2008.11.23.12.43.c6728	Health	Mobile
Blake, H. (2014). Text messaging interventions increase adherence to antiretroviral therapy and smoking cessation. *Evidence-based medicine, 19*(1), 35–6. doi:10.1136/eb-2013-101359	Health	SMS
Boschen, M. J., & Casey, L. M. (2008). The use of mobile telephones as adjuncts to cognitive behavioral psychotherapy. *Professional Psychology: Research and Practice, 39*(5), 546–552. doi:10.1037/0735-7028.39.5.546	Psych	Mobile
Boulos, M. N. K., Brewer, A. C., Karimkhani, C., Buller, D. B., & Dellavalle, R. P. (2014). Mobile medical and health apps: state of the art, concerns, regulatory control and certification. *Online journal of public health informatics, 5*(3), 229. doi:10.5210/ojphi.v5i3.4814	Health	Mobile
Broderick, J. E. (2009). Electronic Diaries: Appraisal and Current Status. *Pharmaceuitcal Medicine, 22*(2), 69–74.	Health	Mobile
Buchholz, S. W., Wilbur, J., Ingram, D., & Fogg, L. (2013). Physical activity text messaging interventions in adults: a systematic review. *Worldviews on evidence-based nursing, 10*(3), 163–73. doi:10.1111/wvn.12002	Health	SMS
Chan, C. V, & Kaufman, D. R. (2010). A technology selection framework for supporting delivery of patient-oriented health interventions in developing countries. *Journal of biomedical informatics, 43*(2), 300–6. doi:10.1016/j.jbi.2009.09.006	Health	Topic
Cole-Lewis, H., & Kershaw, T. (2010). Text messaging as a tool for behavior change in disease prevention and management. *Epidemiologic reviews, 32*(1), 56–69. doi:10.1093/epirev/mxq004	Health	SMS
Crocker, J. B., Crocker, J. T., & Greenwald, J. L. (2012). Telephone follow-up as a primary care intervention for postdischarge outcomes improvement: a systematic review. *The American journal of medicine, 125*(9), 915–21. doi:10.1016/j.amjmed.2012.01.035	Health	Phone
Déglise, C., Suggs, L. S., & Odermatt, P. (2012). Short message service (SMS) applications for disease prevention in developing countries. *Journal of medical Internet research, 14*(1), e3. doi:10.2196/jmir.1823	Health	SMS
Doyle, G. J., Garrett, B., & Currie, L. M. (2013). Integrating mobile devices into nursing curricula: Opportunities for implementation using Rogers' Diffusion of Innovation model. *Nurse education today, 34*(5), 775–782. doi:10.1016/j.nedt.2013.10.021	Health	Mobile
Ebner-Priemer, U. W., & Kubiak, T. (2007). Psychological and Psychophysiological Ambulatory Monitoring. *European Journal of Psychological Assessment, 23*(4), 214–226. doi:10.1027/1015-5759.23.4.214	Psych	Topic
Finitsis, D. J., Pellowski, J. a, & Johnson, B. T. (2014). Text Message Intervention Designs to Promote Adherence to Antiretroviral Therapy (ART): A Meta-Analysis of Randomized Controlled Trials. *PloS one, 9*(2), e88166. doi:10.1371/journal.pone.0088166	Health	SMS

Fjeldsoe, B. S., Marshall, A. L., & Miller, Y. D. (2009). Behavior change interventions delivered by mobile telephone short-message service. *American journal of preventive medicine, 36*(2), 165–73. doi:10.1016/j.amepre.2008.09.040	Psych	Mobile
Franc, S., Daoudi, a, Mounier, S., Boucherie, B., Dardari, D., Laroye, H., Neraud, B., et al. (2011). Telemedicine and diabetes: achievements and prospects. *Diabetes and metabolism, 37*(6), 463–76. doi:10.1016/j.diabet.2011.06.006	Health	Topic
Free, C., Phillips, G., Galli, L., Watson, L., Felix, L., Edwards, P., Patel, V., et al. (2013). The effectiveness of mobile-health technology-based health behaviour change or disease management interventions for health care consumers: a systematic review. *PLoS medicine, 10*(1), e1001362. doi:10.1371/journal.pmed.1001362	Psych	Mobile
Freifeld, C. C., Chunara, R., Mekaru, S. R., Chan, E. H., Kass-Hout, T., Ayala Iacucci, A., & Brownstein, J. S. (2010). Participatory epidemiology: use of mobile phones for community-based health reporting. *PLoS medicine, 7*(12), e1000376. doi:10.1371/journal.pmed.1000376	Health	Mobile
Gentles, S. J., Lokker, C., & McKibbon, K. A. (2010). Health information technology to facilitate communication involving health care providers, caregivers, and pediatric patients: a scoping review. *Journal of medical Internet research, 12*(2), e22. doi:10.2196/jmir.1390	Health	Topic
Gurol-Urganci, I., de Jongh, T., Vodopivec-Jamsek, V., Atun, R., & Car, J. (2013). Mobile phone messaging reminders for attendance at healthcare appointments. *The Cochrane Library.*	Health	SMS
Guse, K., Levine, D., Martins, S., Lira, A., Gaarde, J., Westmorland, W., & Gilliam, M. (2012). Interventions using new digital media to improve adolescent sexual health: a systematic review. *The Journal of adolescent health, 51*(6), 535–43. doi:10.1016/j.jadohealth.2012.03.014	Health	Topic
Guy, R., Hocking, J., Wand, H., Stott, S., Ali, H., & Kaldor, J. (2012). How effective are short message service reminders at increasing clinic attendance? A meta-analysis and systematic review. *Health services research, 47*(2), 614–32. doi:10.1111/j.1475-6773.2011.01342.x	Health	SMS
Haase, R., Schultheiss, T., Kempcke, R., Thomas, K., & Ziemssen, T. (2012). Use and acceptance of electronic communication by patients with multiple sclerosis: a multicenter questionnaire study. *Journal of medical Internet research, 14*(5), e135. doi:10.2196/jmir.2133	Health	Topic
Harrison, V., Proudfoot, J., Wee, P. P., Parker, G., Pavlovic, D. H., & Manicavasagar, V. (2011). Mobile mental health: review of the emerging field and proof of concept study. *Journal of mental health, 20*(6), 509-524. doi:10.3109/09638237.2011.608746	Psych	Mobile
Hasvold, P. E., & Wootton, R. (2011). Use of telephone and SMS reminders to improve attendance at hospital appointments: a systematic review. *Journal of telemedicine and telecare, 17*(7), 358–64. doi:10.1258/jtt.2011.110707	Health	SMS
Hazelwood, A. J. (2008). Using text messaging in the treatment of eating disorders. *Nursing Times, 104*(40), 28 – 29.	Psych	SMS
Head, K. J., Noar, S. M., Iannarino, N. T., & Harrington, N. G. (2013). Efficacy of text messaging-based interventions for health promotion: a meta-analysis. *Social Science & Medicine, 97,* 41-48. doi:10.1016/j.socscimed.2013.08.003	Health	SMS
Herbert, L., Owen, V., Pascarella, L., & Streisand, R. (2013). Text message interventions for children and adolescents with type 1 diabetes: a systematic review. *Diabetes technology and therapeutics, 15*(5), 362–70. doi:10.1089/dia.2012.0291	Health	SMS
Holtz, B., & Lauckner, C. (2012). Diabetes management via mobile phones: a systematic review. *Telemedicine journal and e-health, 18*(3), 175–84. doi:10.1089/tmj.2011.0119	Health	Mobile
Iwaya, L. H., Gomes, M. a L., Simplício, M. a, Carvalho, T. C. M. B., Dominicini, C. K., Sakuragui, R. R. M., Rebelo, M. S., et al. (2013). Mobile health in emerging countries: a survey of research initiatives in Brazil. *International journal of medical informatics, 82*(5), 283–98. doi:10.1016/j.ijmedinf.2013.01.003	Health	Mobile
Jennings, L., & Gagliardi, L. (2013). Influence of mHealth interventions on gender relations in developing countries: a systematic literature review. *International journal for equity in health, 12*(1), 85. doi:10.1186/1475-9276-12-85	Health	Mobile

Joe, J., & Demiris, G. (2013). Older adults and mobile phones for health: a review. *Journal of biomedical informatics, 46*(5), 947–54. doi:10.1016/j.jbi.2013.06.008	Health	Mobile
Johnston, W., Hoffman, S., & Thornton, L. (2014). Mobile health: a synopsis and comment on "Increasing physical activity with mobile devices: a meta-analysis". *Translational behavioral medicine*, 4(1), 4-6. doi:10.1007/s13142-014-0254-3	Health	Mobile
Jones, K. R., Lekhak, N., & Kaewluang, N. (2014). Using mobile phones and short message service to deliver self-management interventions for chronic conditions: a meta-review. *Worldviews on evidence-based nursing, 11*(2), 81–8. doi:10.1111/wvn.12030	Health	SMS
Keogh, E. (2013). Developments in the use of e-health for chronic pain management. *Pain management, 3*(1), 27–33. doi:10.2217/pmt.12.70	Health	Topic
Klasnja, P., & Pratt, W. (2012). Healthcare in the pocket: mapping the space of mobile-phone health interventions. *Journal of biomedical informatics, 45*(1), 184–98. doi:10.1016/j.jbi.2011.08.017	Health	Mobile
Kreps, G. L., & Neuhauser, L. (2010). New directions in eHealth communication: opportunities and challenges. *Patient education and counseling, 78*(3), 329–36. doi:10.1016/j.pec.2010.01.013	Health	eHealth
Krishna, S., & Boren, S. a. (2008). Diabetes Self-Management Care via Cell Phone: A Systematic Review. *Journal of Diabetes Science and Technology, 2*(3), 509–517. doi:10.1177/193229680800200324	Health	Mobile
Krishna, Santosh. (2009). Healthcare via Cell Phones: a systematic review. *Telemedicine and e-Health, 15*(3), 2–4. doi:10.1089/tmj.2008.0099	Health	Mobile
Kumar, S., Nilsen, W. J., Abernethy, A., Atienza, A., Patrick, K., Pavel, M., Riley, W. T., et al. (2013). Mobile health technology evaluation: the mHealth evidence workshop. *American journal of preventive medicine, 45*(2), 228–36. doi:10.1016/j.amepre.2013.03.017	Health	Mobile
Kuntsche, E., & Labhart, F. (2013). Using Personal Cell Phones for Ecological Momentary Assessment. *European Psychologist, 18*(1), 3–11. doi:10.1027/1016-9040/a000127	Psych	Mobile
Lau, P. W., Lau, E. Y., Wong, D. P., & Ransdell, L. (2011). A systematic review of information and communication technology–based interventions for promoting physical activity behavior change in children and adolescents. *Journal of medical Internet research, 13*(3). doi:10.2196/jmir.1533	Psych	eHealth
Lefebvre, C. (2009). Integrating cell phones and mobile technologies into public health practice: a social marketing perspective. *Health promotion practice, 10*(4), 490–4. doi:10.1177/1524839909342849	Health	Mobile
Lehman, B. J. (2011). Getting started: Launching a study in daily life. In M. R. Mehl & T. S. Conner (Eds.), *Handbook of research methods for studying daily life* (pp. 89–107). New York: The Guilford Press.	Psych	Topic
Leon, E. De, Fuentes, L. W., & Cohen, J. E. (2014). Characterizing Periodic Messaging Interventions Across Health Behaviors and Media: Systematic Review. *Journal of Medical Internet Research, 16*(3), e93. doi:10.2196/jmir.2837	Health	Broad
Lewin, S., Lavis, J. N., Oxman, A. D., Bastías, G., Chopra, M., Ciapponi, A., Flottorp, S., et al. (2008). Supporting the delivery of cost-eff ective interventions in primary health-care systems in low-income and middle-income countries: an overview of systematic reviews. *The Lancet, 372*(9642), 928 – 939.	Health	Topic
Liang, X., Wang, Q., Yang, X., Cao, J., Chen, J., Mo, X., Huang, J., et al. (2011). Effect of mobile phone intervention for diabetes on glycaemic control: a meta-analysis. *Diabetic medicine, 28*(4), 455–63. doi:10.1111/j.1464-5491.2010.03180.x	Health	Mobile
Liebow, E. B., Derzon, J. H., Fontanesi, J., Favoretto, A. M., Baetz, R. A., Shaw, C., Thompson, P., et al. (2012). Effectiveness of automated notification and customer service call centers for timely and accurate reporting of critical values: a laboratory medicine best practices systematic review and meta-analysis. *Clinical biochemistry, 45*(13-14), 979–87. doi:10.1016/j.clinbiochem.2012.06.023	Health	Phone
Lightfoot, M. (2012). HIV Prevention for Adolescents: Where Do We Go From Here? *American Psychologist, 53*, 348–356. doi:10.1037/a0029831	Health	Topic

Lim, M. S. C., Hocking, J. S., Hellard, M. E., & Aitken, C. K. (2008). SMS STI: a review of the uses of mobile phone text messaging in sexual health. *International journal of STD and AIDS, 19*(5), 287–90. doi:10.1258/ijsa.2007.007264	Health	SMS
Logan, A. G. (2013). Transforming hypertension management using mobile health technology for telemonitoring and self-care support. *The Canadian journal of cardiology, 29*(5), 579–85. doi:10.1016/j.cjca.2013.02.024	Health	Mobile
Lukasiewicz, M., Fareng, M., Benyamina, a, Blecha, L., Reynaud, M., & Falissard, B. (2007). Ecological momentary assessment in addiction. *Expert review of neurotherapeutics, 7*(8), 939–50. doi:10.1586/14737175.7.8.939	Psych	SMS
Lunny, C., Taylor, D., Memetovic, J., Wärje, O., Lester, R., Wong, T., Ho, K., et al. (2014). Short message service (SMS) interventions for the prevention and treatment of sexually transmitted infections: a systematic review protocol. *Systematic Reviews, 3*, 1–8. doi:10.1186/2046-4053-3-7	Health	SMS
Luxton, D. D., June, J. D., & Comtois, K. A. (2013). Can postdischarge follow-up contacts prevent suicide and suicidal behavior? A review of the evidence. *Crisis, 34*(1), 32–41. doi:10.1027/0227-5910/a000158	Health	Topic
Malbon, K., & Romo, D. (2013). Is it ok 2 txt? Reaching out to adolescents about sexual and reproductive health. *Postgraduate medical journal, 89*(1055), 534–9. doi:10.1136/postgradmedj-2012-131519	Health	SMS
Malinen, K., Rönkä, A., & Sevón, E. (n.d.). *Mobile Diary Methods in Studying Daily Family Life. Encyclopedia of Mobile Phone Behavior* (Volumes 1, 2, & 3). Hershey, PA: IGI Global.	Psych	Mobile
Markowitz, J. T., Harrington, K. R., & Laffel, L. M. B. (2013). Technology to optimize pediatric diabetes management and outcomes. *Current diabetes reports, 13*(6), 877–85. doi:10.1007/s11892-013-0419-3	Health	Topic
Mars, M. (2013). Telemedicine and Advances in Urban and Rural Healthcare Delivery in Africa. *Progress in Cardiovascular Diseases, 56*(3), 326–335. doi:10.1016/j.pcad.2013.10.006	Health	Phone
Mbuagbaw, L., Kop, M. L. Van Der, Lester, R. T., Thirumurthy, H., Pop-eleches, C., Smieja, M., & Dolovich, L. (2013). Mobile phone text messages for improving adherence to antiretroviral therapy (ART): a protocol for an individual patient data meta-analysis of randomised trials. *BMJ Open, 3*, e002954. doi:10.1136/bmjopen-2013-002954	Health	SMS
Mbuagbaw, L., Van der Kop, M. L., Lester, R. T., Thirumurthy, H., Pop-Eleches, C., Ye, C., Smieja, M., et al. (2013). Mobile phone text messages for improving adherence to antiretroviral therapy (ART): an individual patient data meta-analysis of randomised trials. *BMJ open, 3*(12), e003950. doi:10.1136/bmjopen-2013-003950	Health	SMS
McCambridge, J., & Kypri, K. (2011). Can simply answering research questions change behaviour? Systematic review and meta analyses of brief alcohol intervention trials. *PloS one, 6*(10), e23748. doi:10.1371/journal.pone.0023748	Health	Topic
McLean, S., Sheikh, A., Cresswell, K., Nurmatov, U., Mukherjee, M., Hemmi, A., & Pagliari, C. (2013). The impact of telehealthcare on the quality and safety of care: a systematic overview. PloS one, 8(8), e71238. doi:10.1371/journal.pone.0071238	Health	Phone
Megan S C Lim, Hocking, J. S., & Hellard, M. E. (2008). SMS STI: a review of the uses of mobile phone text messaging in sexual health. *International Journal of STD and AIDS, 19*, 287 – 290. doi:10.1258/ijsa.2007.007264.	Health	SMS
Mehl, M. R., Scott, R., Kosslyn, S., & Pinkerton, N. (2014). *Ambulatory Assessment – Methods for Studying Everyday Life.* In R. Scott, S. Kosslyn, & N. Pinkerton (Eds.), Emerging Trends in the Social and Behavioral Sciences (pp. 1–13). Wiley.	Psych	Topic
Mendez, J., & Maher, J. (2012). Evidence supporting the use of text messaging for partner services. *Sexually transmitted diseases, 39*(3), 238–9. doi:10.1097/OLQ.0b013e3182471b31	Health	SMS
Mignerat, M., Lapointe, L., & Vedel, I. (2014). Using telecare for diabetic patients: A mixed systematic review. *Health Policy and Technology, 3*(2), 1–23. doi:10.1016/j.hlpt.2014.01.004	Health	Phone
Militello, L. K., Kelly, S. a, & Melnyk, B. M. (2012). Systematic review of text-messaging interventions to promote healthy behaviors in pediatric and adolescent populations: implications for	Health	SMS

clinical practice and research. *Worldviews on evidence-based nursing, 9*(2), 66–77. doi:10.1111/j.1741-6787.2011.00239.x		
Mukund, B. K. C., & Murray, P. J. (2010). Cell phone short messaging service (SMS) for HIV/AIDS in South Africa: a literature review. *Studies in health technology and informatics*, 160, 530 – 534.	Health	SMS
Nglazi, M. D., Bekker, L.-G., Wood, R., Hussey, G. D., & Wiysonge, C. S. (2013). Mobile phone text messaging for promoting adherence to anti-tuberculosis treatment: a systematic review. *BMC infectious diseases, 13*, 566. doi:10.1186/1471-2334-13-566	Health	SMS
Nguyen, T. T., Jayadeva, V., Cizza, G., Brown, R. J., Nandagopal, R., Rodriguez, L. M., & Rother, K. I. (2014). Challenging recruitment of youth with type 2 diabetes into clinical trials. *The Journal of adolescent health, 54*(3), 247–54. doi:10.1016/j.jadohealth.2013.08.017	Health	Topic
Palmqvist, B., Carlbring, P., & Andersson, G. (2007). Internet-delivered treatments with or without therapist input: does the therapist factor have implications for efficacy and cost? *Expert review of pharmacoeconomics and outcomes research, 7*(3), 291–7. doi:10.1586/14737167.7.3.291	Psych	Topic
Park, L. G., Howie-Esquivel, J., & Dracup, K. (2014). A quantitative systematic review of the efficacy of mobile phone interventions to improve medication adherence. *Journal of advanced nursing, 70*(9), 1932-1953. doi:10.1111/jan.12400	Health	Mobile
Patcai, J. (2011). Polling the audience using text messaging - a tool for medical education. *Medical teacher, 33*(8), 684. doi:10.3109/0142159X.2011.600102	Health	SMS
Patrick, K., Griswold, W. G., Raab, F., & Intille, S. S. (2008). Health and the mobile phone. *American journal of preventive medicine, 35*(2), 177–81. doi:10.1016/j.amepre.2008.05.001	Health	Mobile
Pattishall, A. E., Ellen, S. B., & Spector, N. D. (2013). Bullying, adverse childhood experiences and use of texting to promote behavior change. *Current opinion in pediatrics, 25*(6), 748 – 754.	Psych	eHealth
Proudfoot, J. (2013). The future is in our hands: the role of mobile phones in the prevention and management of mental disorders. *The Australian and New Zealand journal of psychiatry, 47*(2), 111–3. doi:10.1177/0004867412471441	Psych	Mobile
Riaz, T., Riaz, H., Hussain, S. a, & Kherani, D. (2012). SMS reminders- future in self-care management of diabetes mellitus? *Diabetology and metabolic syndrome, 4*(1), 31. doi:10.1186/1758-5996-4-31	Health	SMS
Salema, N.-E. M., Elliott, R. a, & Glazebrook, C. (2011). A systematic review of adherence-enhancing interventions in adolescents taking long-term medicines. *The Journal of adolescent health, 49*(5), 455–66. doi:10.1016/j.jadohealth.2011.02.010	Health	Topic
Sarayani, A., Jahangard-Rafsanjani, Z., Hadjibabaie, M., Ahmadvand, A., Javadi, M., & Gholami, K. (2013). A comprehensive review of adherence to diabetes and cardiovascular medications in Iran; implications for practice and research. *Journal of diabetes and metabolic disorders, 12*(1), 57. doi:10.1186/2251-6581-12-57	Health	Topic
Sepkowitz, K. A. (2012). Adherence to antiretroviral therapy: supervision or support? *The Lancet Infectious Diseases, 12*(2), 97–98. doi:10.1016/S1473-3099(11)70354-1	Health	Topic
Sharp, D. B., & Allman-Farinelli, M. (2014). Feasibility and validity of mobile phones to assess dietary intake. *Nutrition, 30*(11), 1257-1266.doi:10.1016/j.nut.2014.02.020	Health	Mobile
Shaw, R., & Bosworth, H. (2013). Short message service (SMS) text messaging as an intervention medium for weight loss: a literature review. *Health informatics journal, 18*(4), 235 – 250. doi:10.1177/1460458212442422.Short	Health	SMS
Shingleton, R. M., Richards, L. K., & Thompson-Brenner, H. (2013). Using technology within the treatment of eating disorders: a clinical practice review. *Psychotherapy, 50*(4), 576–82. doi:10.1037/a0031815	Health	Broad
Siopis, G., Chey, T., & Allman-Farinelli, M. (2014). A systematic review and meta-analysis of interventions for weight management using text messaging. *Journal of human nutrition and dietetics*, 1–15. doi:10.1111/jhn.12207	Health	SMS
Stinson, J. N. (2009). Improving the assessment of pediatric chronic pain: harnessing the potential of electronic diaries. *Pain research & management, 14*(1), 59–64.	Health	Topic

Svensson, M., & Lagerros, Y. T. (2010). Motivational technologies to promote weight loss--from internet to gadgets. *Patient education and counseling, 79*(3), 356–60. doi:10.1016/j.pec.2010.03.004	Health	Topic
T, D. J., Atun, R., & Car, J. (2013). *Mobile phone messaging reminders for attendance at healthcare appointments* (Review). Cochrane Review, (12).	Health	SMS
Tang, J., Abraham, C., Greaves, C., & Yates, T. (2014). Self-directed interventions to promote weight loss: a systematic review of reviews. *Journal of medical Internet research, 16*(2), e58. doi:10.2196/jmir.2857	Health	Broad
Terry, M. (2008). Text Messaging in Healthcare: The elephant knocking at the door. *Telemedicine and e-Health, 14*(6), 520–524. doi:10.1089/tmj.2008.8495	Health	SMS
Thayer, R. E., & Hutchinson, K. E. (2011). Improving accuracy of adolescents' substance use reports via text messaging. *Addiction, 107*, 1015–1017. doi:10.1111/j.1360-0443.2011.03768.x	Health	SMS
Van Velthoven, M. H. M. M. T., Brusamento, S., Majeed, A., & Car, J. (2013). Scope and effectiveness of mobile phone messaging for HIV / AIDS care: A systematic review. *Psychology, Health and Medicine, 18*(2), 182–202. doi:10.1080/13548506.2012.701310	Health	SMS
Wei, J., Hollin, I., & Kachnowski, S. (2010). A review of the use of mobile phone text messaging in clinical and healthy behaviour interventions. *Journal of telemedicine and telecare, 17*(1), 41 – 48. doi:10.1258/jtt.2010.100322	Health	SMS
Wu, Y. P., & Hommel, K. A. (2014). Using Technology to Assess and Promote Adherence to Medical Regimens in Pediatric Chronic Illness. *The Journal of Pediatrics, 164*(4), 922–927. doi:10.1016/j.jpeds.2013.11.013	Health	Topic
Yeager, V. A., & Menachemi, N. (2011). *Text messaging in health care: a systematic review of impact studies. Advances in Health Care Management* (Vol. 11, pp. 235–261). Emerald Group Publishing Ltd. doi:10.1108/S1474-8231(2011)0000011013	Health	SMS
Zurovac, D., Talisuna, A. O., & Snow, R. W. (2012). Mobile Phone Text Messaging?: Tool for Malaria Control in Africa. *PloS medicine, 9*(2), 1–6. doi:10.1371/journal.pmed.1001176	Health	SMS

Note. Papers containing multiple studies are identified after the citation.

Appendix 2 Table 3. *Constituent papers for the data collection category.*

Paper	Focus	Type	Topic
Aguilera, A., & Muñoz, R. F. (2011). Text messaging as an adjunct to CBT in low-income populations: A usability and feasibility pilot study. Professional Psychology: *Research and Practice, 42*(6), 472–478. doi:10.1037/a0025499	Psych	Self-Report	depression
Ainsworth, J., Palmier-Claus, J. E., Machin, M., Barrowclough, C., Dunn, G., Rogers, A., Buchan, I., et al. (2013). A comparison of two delivery modalities of a mobile phone-based assessment for serious mental illness: native smartphone application vs text-messaging only implementations. *Journal of medical Internet research, 15*(4), e60. doi:10.2196/jmir.2328	Psych	Self-Report	schizophrenia
Alfven, G. (2010). SMS Pain Diary: A Method for Real Time Data Capture of Recurrent Pain in Childhood. *Acta Paediatricia, 99*(7), 1047 – 1053. doi:10.1111/j.1651-2227.2010.01735.x	Health	Self-Report	Pain diary
Andreatta, P., Debpuur, D., Danquah, A., & Perosky, J. (2011). Using cell phones to collect postpartum hemorrhage outcome data in rural Ghana. *International journal of gynaecology and obstetrics, 113*(2), 148–51. doi:10.1016/j.ijgo.2010.11.020	Health	Clinical reporting	Postpartum hemorrhage
Anhøj, J., & Møldrup, C. (2004). Feasibility of collecting diary data from asthma patients through mobile phones and SMS (short message service): response rate analysis and focus group evaluation from a pilot study. *Journal of medical Internet research, 6*(4), e42. doi:10.2196/jmir.6.4.e42	Health	Self-Report	athsma
Asiimwe, C., Gelvin, D., Lee, E., Ben Amor, Y., Quinto, E., Katureebe, C., Sundaram, L., et al. (2011). Use of an innovative, affordable, and open-source short message service-based tool to monitor malaria in remote areas of Uganda. *The American journal of tropical medicine and hygiene, 85*(1), 26–33. doi:10.4269/ajtmh.2011.10-0528	Health	Clinical reporting	Malaria surveillance
Axén, I., Bergström, G., & Bodin, L. (2014). Using few and scattered time points for analysis of a variable course of pain can be misleading: an example using weekly text message data. *The Spine Journal, 14*(8), 1454-1459. doi:10.1016/j.spinee.2013.08.035	Health	Self-Report	Pain diary
Axén, I., Bodin, L., Bergström, G., Halasz, L., Lange, F., Lövgren, P. W., Rosenbaum, A., et al. (2012). The use of weekly text messaging over 6 months was a feasible method for monitoring the clinical course of low back pain in patients seeking chiropractic care. *Journal of clinical epidemiology, 65*(4), 454–61. doi:10.1016/j.jclinepi.2011.07.012	Health	Self-Report	Lower back pain monitoring
Axén, I., Bodin, L., Kongsted, A., Wedderkopp, N., Jensen, I., & Bergström, G. (2012). Analyzing repeated data collected by mobile phones and frequent text messages. An example of low back pain measured weekly for 18 weeks. *BMC medical research methodology, 12*(1), 105. doi:10.1186/1471-2288-12-105	Health	Self-Report	Back pain monitoring
Baron, S., Goutard, F., Nguon, K., & Tarantola, A. (2013). Use of a Text Message-Based Pharmacovigilance Tool in Cambodia: Pilot Study. *Journal of medical internet research, 15*, 1–8. doi:10.2196/jmir.2477	Health	Self-Report	Post-vaccination status

Barrington, J., Wereko-Brobby, O., Ward, P., Mwafongo, W., & Kungulwe, S. (2010). SMS for Life: a pilot project to improve anti-malarial drug supply management in rural Tanzania using standard technology. *Malaria journal, 9*(1), 298. doi:10.1186/1475-2875-9-298	Health	Clinical reporting	Malaria medication stock reporting
Batch, B. C., Tyson, C., Bagwell, J., Corsino, L., Intille, S., Lin, P.-H., Lazenka, T., et al. (2014). Weight loss intervention for young adults using mobile technology: Design and rationale of a randomized controlled trial - Cell Phone Intervention for You (CITY). *Contemporary clinical trials, 37*(2), 333–341. doi:10.1016/j.cct.2014.01.003	Health	Self-Report	Screening for later intervention
Bauer, S., De Niet, J., Timman, R., & Kordy, H. (2010). Enhancement of care through self-monitoring and tailored feedback via text messaging and their use in the treatment of childhood overweight. *Patient education and counseling, 79*(3), 315–9. doi:10.1016/j.pec.2010.03.014	Health	Self-Report	Eating, exercise behavoir
Bauer, S., Okon, E., Meermann, R., & Kordy, H. (2012). Technology-Enhanced Maintenance of Treatment Gains in Eating Disorders: Efficacy of an Intervention Delivered via Text Messaging. *Journal of consulting and clinical psychology, 80*(4), 700–706. doi:10.1037/a0028030	Health	Self-Report	Eating disorders
Bauer, S., Percevic, R., Okon, E., Meermann, R., & Kordy, H. (2003). Use of text messaging in the aftercare of patients with bulimia nervosa. *European Eating Disorders Review, 11*(3), 279–290. doi:10.1002/erv.521	Health	Self-Report	Post-discharge eating disorder feedback
Bauer, Stephanie, De Niet, J., Timman, R., & Kordy, H. (2010). Enhancement of care through self-monitoring and tailored feedback via text messaging and their use in the treatment of childhood overweight. *Patient education and counseling, 79*(3), 315–9. doi:10.1016/j.pec.2010.03.014	Health	Self-Report	Obesity
Berkman, E. T., Dickenson, J., Falk, E. B., & Lieberman, M. D. (2011). Using SMS Text Messaging to Assess Moderators of Smoking Reduction: Validating a New Tool for Ecological Measurement of Health Behaviors. *Health Psychology, 30*(2), 186–194. doi:10.1037/a0022201	Health	Self-Report	Smoking cessation
Bexelius, C., Merk, H., Sandin, S., Ekman, A., Nyrén, O., Kühlmann-Berenzon, S., Linde, A., et al. (2009). SMS versus telephone interviews for epidemiological data collection: feasibility study estimating influenza vaccination coverage in the Swedish population. *European journal of epidemiology, 24*(2), 73–81. doi:10.1007/s10654-008-9306-7	Health	Self-Report	Influenza vaccination
Bopp, J. M., Miklowitz, D. J., Goodwin, G. M., Stevens, W., Rendell, J. M., & Geddes, J. R. (2010). The longitudinal course of bipolar disorder as revealed through weekly text-messaging: a feasibility study. *Bipolar Disorders, 12*(3), 327–334. doi:10.1111/j.1399-5618.2010.00807.x.The	Psych	Self-Report	Bipolar disorder symptoms
Broderick, C. R., Herbert, R. D., Latimer, J., Mathieu, E., Van Doorn, N., & Curtin, J. (2012). Feasibility of short message service to document bleeding episodes in children with haemophilia. *Haemophilia, 18*(6), 906–10. doi:10.1111/j.1365-2516.2012.02869.x	Health	Self-Report	Bleeding episodes in haemophilia

Car, N. J., Christen, E. W., Hornbuckle, J. W., & Moore, G. a. (2012). Using a mobile phone Short Messaging Service (SMS) for irrigation scheduling in Australia – Farmers' participation and utility evaluation. *Computers and Electronics in Agriculture, 84*, 132–143. doi:10.1016/j.compag.2012.03.003	Health	Self-Report	Irrigation in farmland
Chen, Y., Chin, M., Greenberg, S., Johnstone, C., & McGuinness, J. (2012). Post-tonsillectomy pain in 24 children - utilising short message service (SMS) to assess postoperative outcomes. *Clinical otolaryngology, 37*(5), 412–4. doi:10.1111/j.1749-4486.2012.02521.x	Health	Self-Report	Post tonsillectomy pain monitoring
Chib, A., Wilkin, H., Ling, L. X., Hoefman, B., & Van Biejma, H. (2012). You have an important message! Evaluating the effectiveness of a text message HIV/AIDS campaign in Northwest Uganda. *Journal of health communication, 17*(1), 146–57. doi:10.1080/10810730.2011.649104	Health	Self-Report	HIV knowledge
Cocco, M., & Tuzzi, A. (2012). New data collection modes for surveys: a comparative analysis of the influence of survey mode on question-wording effects. *Quality and Quantity, 47*(6), 3135-3152. doi:10.1007/s11135-012-9708-1	Health	Self-Report	Attitudes toward HIV/homosexuality
Conner, T. (n.d.). The Daily Life Study.	Health	Self-Report	
Conner, T. S., & Reid, K. A. (2012). Effects of intensive mobile happiness reporting in daily life. *Social psychological and personality science, 3*(3), 315 – 323.	Psych	Self-Report	Happiness
Cooper, G., Walker, J., Harris, D., Stewart, R., Nicol, D., & Ogg, M. (2011). Use of text messaging to audit early clinical outcome following vasectomy in primary care. *The British journal of general practice, 61*(585), 280–2. doi:10.3399/bjgp11X567135	Health	Self-Report	Post-vasectomy health
Curran, K., Mugo, N. R., Kurth, A., Ngure, K., Heffron, R., Donnell, D., Celum, C., et al. (2013). Daily Short Message Service Surveys to Measure Sexual Behavior and Pre-exposure Prophylaxis Use Among Kenyan Men and Women. *AIDS and Behavior, 17*, 2977–2985. doi:10.1007/s10461-013-0510-4	Health	Self-Report	Sexual behavior / condom use
De Lepper, A. M., Eijkemans, M. J. C., Van Beijma, H., Loggers, J. W., Tuijn, C. J., & Oskam, L. (2013). Response patterns to interactive SMS health education quizzes at two sites in Uganda: a cohort study. Tropical medicine & international health, 18(4), 516–21. doi:10.1111/tmi.12059 (two studies)	Health	Self-Report	Knowledge of health topics (HIV, STD, malaria, tuberculosis, circumcision, demographics)
De Niet, J, Timman, R., Bauer, S., Van den Akker, E., Buijks, H., De Klerk, C., Kordy, H., et al. (2012). The effect of a short message service maintenance treatment on body mass index and psychological well-being in overweight and obese children: a randomized controlled trial. *Pediatric obesity, 7*(3), 205–19. doi:10.1111/j.2047-6310.2012.00048.x	Health	Self-Report	Obseity behavior
De Niet, Judith, Timman, R., Bauer, S., Van den Akker, E., De Klerk, C., Kordy, H., & Passchier, J. (2012). Short message service reduces dropout in childhood obesity treatment: a randomized controlled trial. *Health psychology, 31*(6), 797–805. doi:10.1037/a0027498	Health	Self-Report	Obesity management
Depp, C., Mausbach, B., Granholm, E., Cardenas, V., Ben-Zeev, D., Patterson, T. L., Lebowitz, B. D., et al. (2010). Mobile interventions for severe mental illness: design and preliminary data from three	Psych	Self-Report	Schizophrenic symptom monitoring

approaches. *The Journal of nervous and mental disease, 198*(10), 715–21. doi:10.1097/NMD.0b013e3181f49ea3			
Devine, S., Bull, S., H, M. P., Dreisbach, S., & Shlay, J. (2014). Enhancing a Teen Pregnancy Prevention Program With Text Messaging: Engaging Minority Youth to Develop TOP Plus Text. *Journal of Adolescent Health, 54*(3), S78–S83. doi:10.1016/j.jadohealth.2013.12.005	Health	Self-Report	Sexual health education
Dick, J. J., Nundy, S., Solomon, M. C., Bishop, K. N., Chin, M. H., & Peek, M. E. (2011). Feasibility and usability of a text message-based program for diabetes self-management in an urban African-American population. *Journal of diabetes science and technology, 5*(5), 1246–54.	Health	Self-Report	Diabetes medication adherence
Donaldson, E. L., Fallows, S., & Morris, M. (2014). A text message based weight management intervention for overweight adults. *Journal of human nutrition and dietetics, 27*(2), 90–7. doi:10.1111/jhn.12096	Health	Self-Report	Habits to change obesity
Dowshen, N., Kuhns, L. M., Gray, C., Lee, S., & Garofalo, R. (2013). Feasibility of interactive text message response (ITR) as a novel, real-time measure of adherence to antiretroviral therapy for HIV+ youth. *AIDS and behavior, 17*(6), 2237–43. doi:10.1007/s10461-013-0464-6	Health	Self-Report	HIV medication adherence
Du, X., Wang, W., Helena van Velthoven, M., Chen, L., Scherpbier, R. W., Zhang, Y., Wu, Q., et al. (2013). mHealth Series: Text messaging data collection of infant and young child feeding practice in rural China - a feasibility study. *Journal of global health, 3*(2), 020403. doi:10.7189/jogh.03.020403	Health	Self-Report	Young child feeding practise
Dunstan, D., & Tooth, S. M. (2012). Using technology to improve patient assessment and outcome evaluation. *Rural and remote health, 12* (2048), 1-3.	Psych	Self-Report	Mood ratings
Ekegren, C., Gabbe, B., & Finch, C. (2013). Tracking injuries via SMS in community Australian football. *Journal of Science and Medicine in Sport, 16,* e54–e55. doi:10.1016/j.jsams.2013.10.131	Health	Call for contact	Injury detection in footballers
Ekegren, C., Gabbe, B., & Finch, C. (2014). Injury reporting via sms text messaging in community sport. *British journal of sports medicine, 48*(7), 590. doi:10.1136/bjsports-2014-093494.82	Health	Clinical reporting	Injury reporting
Faghanipour, S., Hajikazemi, E., Nikpour, S., Shariatpanahi, S. A.-S., & Hosseini, A. F. (2013). Mobile Phone Short Message Service (SMS) for Weight Management in Iranian Overweight and Obese Women: A Pilot Study. *International journal of telemedicine and applications, 2013,* 5. doi:10.1155/2013/785654	Health	Self-Report	Weight management
Fernandez, K. C., Johnson, M. R., & Rodebaugh, T. L. (2013). TelEMA: a low-cost and user-friendly telephone assessment platform. *Behavior research methods, 45*(4), 1279–91. doi:10.3758/s13428-012-0287-9	Psych	Self-Report	Depression, stress, anxiety
Ferrer-Roca, O., Cárdenas, a, Diaz-Cardama, a, & Pulido, P. (2004). Mobile phone text messaging in the management of diabetes. *Journal of telemedicine and telecare, 10*(5), 282–5.	Health	Self-Report	Diabetes management
Githinji, S., Kigen, S., Memusi, D., Nyandigisi, A., Mbithi, A. M., Wamari, A., Muturi, A. N., et al. (2013). Reducing stock-outs of life saving malaria commodities using mobile phone text-messaging:	Health	Clinical reporting	Reporting malaria medication stock

SMS for life study in Kenya. *PloS one, 8*(1), e54066. doi:10.1371/journal.pone.0054066			
Githinji, S., Kigen, S., Memusi, D., Nyandigisi, A., Wamari, A., Muturi, A., Jagoe, G., et al. (2014). Using mobile phone text messaging for malaria surveillance in rural Kenya. *Malaria journal, 13*(1), 107. doi:10.1186/1475-2875-13-107	Health	Clinical reporting	Malaria surveillance
Gold, J., Aitken, C. K., Dixon, H. G., Lim, M. S. C., Gouillou, M., Spelman, T., Wakefield, M., et al. (2011). A randomised controlled trial using mobile advertising to promote safer sex and sun safety to young people. *Health education research, 26*(5), 782–94. doi:10.1093/her/cyr020 (two studies)	Health	Self-Report	Sun smart quizzes
Gonzales, R., Ang, A., Murphy, D. a, Glik, D. C., & Anglin, M. D. (2014). Substance use recovery outcomes among a cohort of youth participating in a mobile-based texting aftercare pilot program. *Journal of substance abuse treatment, 47*(1), 20-26. doi:10.1016/j.jsat.2014.01.010	Health	Self-Report	Substance use recovery
Gram, B., Holtermann, A., Bültmann, U., Sjøgaard, G., & Søgaard, K. (2012). Does an exercise intervention improving aerobic capacity among construction workers also improve musculoskeletal pain, work ability, productivity, perceived physical exertion, and sick leave: a randomized controlled trial. *Journal of occupational and environmental medicine, 54*(12), 1520–6. doi:10.1097/JOM.0b013e318266484a	Psych	Self-Report	Physical pain associated with construction work
Granholm, E., Ben-Zeev, D., Link, P. C., Bradshaw, K. R., & Holden, J. L. (2012). Mobile Assessment and Treatment for Schizophrenia (MATS): a pilot trial of an interactive text-messaging intervention for medication adherence, socialization, and auditory hallucinations. *Schizophrenia bulletin, 38*(3), 414–25. doi:10.1093/schbul/sbr155	Psych	Self-Report	Schizophrenic symptoms
Haberer, J. E., Kiwanuka, J., Nansera, D., Wilson, I. B., & Bangsberg, D. R. (2010). Challenges in using mobile phones for collection of antiretroviral therapy adherence data in a resource-limited setting. *AIDS and behavior, 14*(6), 1294–301. doi:10.1007/s10461-010-9720-1	Health	Self-Report	Antiretroviral therapy adherence of Children
Haller, D. M., Sanci, L. a, Patton, G. C., & Sawyer, S. M. (2009). Text message communication in primary care research: a randomized controlled trial. *Family practice, 26*(4), 325–30. doi:10.1093/fampra/cmp040	Health	Self-Report	Medical care feedback
Haller, D., Sanci, L., Sawyer, S., Coffey, C., & Patton, G. (2006). R U OK 2 TXT 4 RESEARCH? Feasibility of text message communication in primary care research. *Australian family physician, 35*(3), 175–6.	Health	Self-Report	Follow-up after appointment
Harris, L. T., Lehavot, K., Huh, D., Yard, S., Andrasik, M. P., Dunbar, P. J., & Simoni, J. M. (2010). Two-way text messaging for health behavior change among human immunodeficiency virus-positive individuals. *Telemedicine journal and e-health, 16*(10), 1024–9. doi:10.1089/tmj.2010.0050	Health	Self-Report	HIV medication information
Haug, S., Meyer, C., Groß, B., Schorr, G., Thyrian, J. R., Kordy, H., Bauer, S., et al. (2008). Kontinuierliche individuelle Förderung der Rauchabstinenz bei sozial benachteiligten jungen Erwachsenen über	Health	Self-Report	Smoking cessation

das Handy - Ergebnisse einer Pilotstudie. *Gesundheitswesen, 70*(6), 364 – 371. doi:10.1055/s-2008-1080932			
Holtz, B., & Whitten, P. (2009). Managing asthma with mobile phones: a feasibility study. *Telemedicine journal and e-health, 15*(9), 907–9. doi:10.1089/tmj.2009.0048	Health	Self-Report	Asthma monitoring
Horne, G., & Biggs, J. (2011). Gaining "real-time" feedback to influence patient and family care. *BMJ supportive and palliative care, 1*(2), 200. doi:10.1136/bmjspcare-2011-000100.4	Health	Self-Report	Feedback on medical services
Ingersoll, K., Dillingham, R., Reynolds, G., Hettema, J., Freeman, J., Hosseinbor, S., & Winstead-Derlega, C. (2014). Development of a personalized bidirectional text messaging tool for HIV adherence assessment and intervention among substance abusers. *Journal of substance abuse treatment, 46*(1), 66–73. doi:10.1016/j.jsat.2013.08.002	Health	Self-Report	HIV medication
Iribarren, S., Beck, S., Pearce, P. F., Chirico, C., Etchevarria, M., Cardinale, D., & Rubinstein, F. (2013). TextTB: A Mixed Method Pilot Study Evaluating Acceptance, Feasibility, and Exploring Initial Efficacy of a Text Messaging Intervention to Support TB Treatment Adherence. *Tuberculosis research and treatment*, 2013. doi:10.1155/2013/349394	Health	Self-Report	Tuberculosis treatment
Irvine, L., Falconer, D. W., Jones, C., Ricketts, I. W., Williams, B., & Crombie, I. K. (2012). Can text messages reach the parts other process measures cannot reach: an evaluation of a behavior change intervention delivered by mobile phone? *PloS one, 7*(12), e52621. doi:10.1371/journal.pone.0052621	Health	Self-Report	Drinking intervention
Jian, W.S., Hsu, M.H., Sukati, H., Syed Abdul, S., Scholl, J., Dube, N., Hsu, C.K., et al. (2012). LabPush: a pilot study of providing remote clinics with laboratory results via short message service (SMS) in Swaziland, Africa. *PloS one, 7*(9), e44462. doi:10.1371/journal.pone.0044462	Health	Clinical reporting	Providing pathology information
Johansen, B., & Wedderkopp, N. (2010). Comparison between data obtained through real-time data capture by SMS and a retrospective telephone interview. *Chiropractic and osteopathy, 18*(10), 1–7.	Health	Self-Report	Back pain monitoring
Kamanga, A., Moono, P., Stresman, G., Mharakurwa, S., & Shiff, C. (2010). Rural health centres, communities and malaria case detection in Zambia using mobile telephones: a means to detect potential reservoirs of infection in unstable transmission conditions. *Malaria journal, 9*, 96. doi:10.1186/1475-2875-9-96	Health	Clinical reporting	Malaria surveillance
Katona, L. B., Rosen, J. M., Vu, N. C., Nguyen, C. K., Dang, L. T., Thiem, V. D., Nguyen, K. C., et al. (2014). A New Paradigm for Disease Surveillance in Vietnam. *Telemedicine journal and e-health, 20*(5), 3–5. doi:10.1089/tmj.2013.0250	Health	Clinical reporting	Disease surveillance
Kazi, A. M., Murtaza, A., Khoja, S., & Ali, S. A. (2014). Lessons from the field Monitoring polio supplementary immunization activities using an automated short text messaging system in Karachi, Pakistan. *Bulletin of the World Health Organization, 92*, 220–225. doi:http://dx.doi.org/10.2471/BLT.13.122564	Health	Self-Report	Asking if vaccinator visited
Kew, S. (2010). Text messaging: an innovative method of data collection in medical research. *BMC research notes, 3*(1), 342. doi:10.1186/1756-0500-3-342	Health	Self-Report	Medication adherence for irritable bowel syndrome

Khosropour, C. M., Johnson, B., Ricca, A. V, & Sullivan, P. S. (2013). Enhancing retention of an Internet-based cohort study of men who have sex with men (MSM) via text messaging: randomized controlled trial. *Journal of medical Internet research, 15*(8), e194. doi:10.2196/jmir.2756	Health	Self-Report	HIV health
Kibengo, F. M., Ruzagira, E., Katende, D., Bwanika, A. N., Bahemuka, U., Haberer, J. E., Bangsberg, D. R., et al. (2013). Safety, adherence and acceptability of intermittent tenofovir/emtricitabine as HIV pre-exposure prophylaxis (PrEP) among HIV-uninfected Ugandan volunteers living in HIV-serodiscordant relationships: a randomized, clinical trial. *PloS one, 8*(9), e74314. doi:10.1371/journal.pone.0074314	Health	Self-Report	Condom use in HIV uninfected individuals
Kim, H.S., Kim, N.C., & Ahn, S.H. (2006). Impact of a nurse short message service intervention for patients with diabetes. *Journal of nursing care quality, 21*(3), 266–71.	Health	Self-Report	Diabetes behavior
Kolodziejczyk, J. K., Norman, G. J., Barrera-Ng, A., Dillon, L., Marshall, S., Arredondo, E., & Patrick, K. (2013). Feasibility and effectiveness of an automated bilingual text message intervention for weight loss: Pilot study. *JMIR research protocols, 2*(2).	Health	Self-Report	Weight management
Kongsted, A., & Leboeuf-Yde, C. (2009). The Nordic back pain subpopulation program--individual patterns of low back pain established by means of text messaging: a longitudinal pilot study. *Chiropractic and osteopathy, 17*, 11. doi:10.1186/1746-1340-17-11	Health	Self-Report	Lower back pain recovery
Kuntsche, E., & Cooper, M. L. (2010). Drinking to have fun and to get drunk: motives as predictors of weekend drinking over and above usual drinking habits. *Drug and alcohol dependence, 110*(3), 259–62. doi:10.1016/j.drugalcdep.2010.02.021	Health	Self-Report	Alcohol intake
Kuntsche, E., & Robert, B. (2009). Short Message Service (SMS) Technology in Alcohol Research - A Feasibility Study. *Alcohol and Alcoholism, 44*(4), 423–428. doi:10.1093/alcalc/agp033	Health	Self-Report	Alcohol intake
L'Engle, K. L., Vahdat, H. L., Ndakidemi, E., Lasway, C., & Zan, T. (2013). Evaluating feasibility, reach and potential impact of a text message family planning information service in Tanzania. *Contraception, 87*(2), 251–6. doi:10.1016/j.contraception.2012.07.009	Health	Self-Report	Oral contraceptive use
Lagerros, Y. T., Sandin, S., Bexelius, C., Litton, J.E., & Löf, M. (2012). Estimating physical activity using a cell phone questionnaire sent by means of short message service (SMS): a randomized population-based study. *European journal of epidemiology, 27*(7), 561–6. doi:10.1007/s10654-012-9708-4	Health	Self-Report	Physical activity
Lang, L. (2009). Text messaging may help children to fight off obesity. *Gastroenterology, 136*(1), 7–8. doi:10.1053/j.gastro.2008.11.047	Health	Self-Report	Physical activity
Lau, E. Y., Lau, P. W. C., Chung, P.-K., Ransdell, L. B., & Archer, E. (2012). Evaluation of an Internet-short message service-based intervention for promoting physical activity in Hong Kong Chinese adolescent school children: a pilot study. *Cyberpsychology, behavior and social networking, 15*(8), 425–34. doi:10.1089/cyber.2012.0161	Health	Self-Report	Physical activity
Lee, S. S. S., Xin, X., Lee, W. P., Sim, E. J., Tan, B., Bien, M. P. G., Lau, A. S. T., et al. (2013). The feasibility of using SMS as a health survey tool: an exploratory study in patients with rheumatoid	Health	Self-Report	Quality of life

arthritis. *International journal of medical informatics, 82*(5), 427–34. doi:10.1016/j.ijmedinf.2012.12.003 (two studies)			
Lewis, M. a, Uhrig, J. D., Bann, C. M., Harris, J. L., Furberg, R. D., Coomes, C., & Kuhns, L. M. (2013). Tailored text messaging intervention for HIV adherence: a proof-of-concept study. *Health psychology, 32*(3), 248–53. doi:10.1037/a0028109	Health	Self-Report	HIV medication adherence
Li, Y., Wang, W., Van Velthoven, M. H., Chen, L., Car, J., Rudan, I., Zhang, Y., et al. (2013). Text Messaging Data Collection for Monitoring an Infant Feeding Intervention Program in Rural China: Feasibility Study. *Journal of Medical Internet Research, 15*(12), e269.	Health	Self-Report	Infant feeding
Lim, M. S. C., Sacks-Davis, R., Aitken, C. K., Hocking, J. S., & Hellard, M. E. (2010). Randomised Controlled Trial of Paper, Online and SMS Diaries for Collecting Sexual Behavior Information from Young People. *Journal of Epidemiology and Community Health, 64*(10), 885–889. doi:10.1136/jech.2008.085316	Health	Self-Report	Sexual partner characteristics
Lin, Y., & Heffernan, C. (2011). Accessible and inexpensive tools for global HPAI surveillance: A mobile-phone based system. *Preventive veterinary medicine, 98*(2-3), 209–14. doi:10.1016/j.prevetmed.2010.10.003	Health	Clinical reporting	Tracking HPAI (avian influenza) spread
Macedo, L. G., Maher, C. G., Latimer, J., & McAuley, J. H. (2012). Feasibility of using short message service to collect pain outcomes in a low back pain clinical trial. *Spine, 37*(13), 1151–5. doi:10.1097/BRS.0b013e3182422df0 (two studies)	Health	Self-Report	Lower back pain
Magee, M., Isakov, A., Paradise, H., & Sullivan, P. (2011). Mobile phones and short message service texts to collect situational awareness data during simulated public health critical events. *American journal of disaster medicine, 6*(6), 379–385.	Health	Self-Report	Mock public health emergency test
Malinen, K., Rõnkã, A., Tolvanen, A., Sevón, E., & Jokinen, K. (2014). Fluctuation in children's emotions: a mobile diary study. In press.	Psych	Self-Report	emotion ratings
Mason, M., Benotsch, E. G., Way, T., Kim, H., & Snipes, D. (2014). Text messaging to increase readiness to change alcohol use in college students. *The journal of primary prevention, 35*(1), 47–52. doi:10.1007/s10935-013-0329-9	Health	Self-Report	Problem drinking habits
Mohammed, S., Siddiqi, O., Ali, O., Habib, A., Haqqi, F., Kausar, M., & Khan, A. (2012). User engagement with and attitudes towards an interactive SMS reminder system for patients with tuberculosis. *Journal of telemedicine and telecare, 18*(7), 404 – 408. doi:10.1258/jtt.2012.120311	Health	Self-Report	Tuberculosis treatment
Møldrup, C. (2007). Individualised health marketing using SMS — A smoking cessation case. *Journal of Medical Marketing, 7*(3), 255–259. doi:10.1057/palgrave.jmm.5050087	Health	Self-Report	Smoking cessation
Moore, S. C., Crompton, K., Goozen, S. Van, Bree, M. Van Den, Bunney, J., & Lydall, E. (2013). A feasibility study of short message service text messaging as a surveillance tool for alcohol consumption and vehicle for interventions in university students. *BMC Public Health, 13,* 1011. doi:10.1186/1471-2458-13-1011 (two studies)	Health	Self-Report	Daily alcohol consumption
Mulvaney, A., & Herbold, N. (2013). The texting athlete: using text and picture messages to record food intake at sporting events.	Health	Self-Report	Food intake

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Journal of nutrition education and behavior, 45(4), 374–6. doi:10.1016/j.jneb.2012.12.003			
Mutua, G., Sanders, E., Mugo, P., Anzala, O., Haberer, J. E., Bangsberg, D., Barin, B., et al. (2012). Safety and adherence to intermittent pre-exposure prophylaxis (PrEP) for HIV-1 in African men who have sex with men and female sex workers. *PloS one, 7*(4), e33103. doi:10.1371/journal.pone.0033103	Health	Self-Report	HIV retroviral medication adherence
Ostojic, V., Cvoriscec, B., Ostojic, S. B., Reznikoff, D., Stipic-Markovic, A., & Tudjman, Z. (2005). Improving asthma control through telemedicine: a study of short-message service. *Telemedicine journal and e-health, 11*(1), 28–35. doi:10.1089/tmj.2005.11.28	Health	Self-Report	Asthma montoring
Palmier-Claus, J. E., Rogers, A., Ainsworth, J., Machin, M., Barrowclough, C., Laverty, L., Barkus, E., et al. (2013). Integrating mobile-phone based assessment for psychosis into people's everyday lives and clinical care: a qualitative study. *BMC psychiatry, 13*(1), 34. doi:10.1186/1471-244X-13-34	Psych	Self-Report	Schizophrenic thoughts
Patrick, K., Raab, F., Adams, M. a, Dillon, L., Zabinski, M., Rock, C. L., Griswold, W. G., et al. (2009). A text message-based intervention for weight loss: randomized controlled trial. Journal of medical *Internet research, 11*(1), e1. doi:10.2196/jmir.1100	Health	Self-Report	Weight management
Prabhakaran, L., Chee, W. Y., Chua, K. C., Abisheganaden, J., & Wong, W. M. (2010). The use of text messaging to improve asthma control: a pilot study using the mobile phone short messaging service (SMS). *Journal of telemedicine and telecare, 16*(5), 286–90. doi:10.1258/jtt.2010.090809	Health	Self-Report	Asthma montoring
Rami, B., Popow, C., Horn, W., Waldhoer, T., & Schober, E. (2006). Telemedical support to improve glycemic control in adolescents with type 1 diabetes mellitus. *European journal of pediatrics, 165*(10), 701–5. doi:10.1007/s00431-006-0156-6	Health	Self-Report	Diabetes management
Ranney, M (2014) unpublished.	Psych	Self-Report	
Ravert, R., Calix, S. I., & Sullivan, M. J. (2010). Research In Brief: Using Mobile Phones to Collect Daily Experience Data From College Undergraduates. *Journal of College Student Development, 51*(3), 343–352. doi:10.1353/csd.0.0134	Psych	Self-Report	What you're doing
Reid, S. C., Kauer, S. D., Dudgeon, P., Sanci, L. a, Shrier, L. a, & Patton, G. C. (2009). A mobile phone program to track young people's experiences of mood, stress and coping. Development and testing of the mobiletype program. *Social psychiatry and psychiatric epidemiology, 44*(6), 501–7. doi:10.1007/s00127-008-0455-5	Psych	Self-Report	Mood, stress and coping
Rhee, H., Allen, J., Mammen, J., & Swift, M. (2014). Mobile phone-based asthma self-management aid for adolescents (mASMAA): a feasibility study. *Patient preference and adherence, 8*, 63–72. doi:10.2147/PPA.S53504	Health	Self-Report	Asthma montoring
Riordan, B., Scarf, D., & Conner, T. S. (n.d.). Orientation week: a gateway to persistent heavy drinking? (in preparation).	Health	Self-Report	Drinks during orientation week
Roberts, A., & Gorman, A. (2009). Short message service for outpatient data collection. *British journal of anaesthesia, 102*(3), 435–6. doi:10.1093/bja/aen398	Health	Self-Report	Pain scores
Robinson, S., Perkins, S., Bauer, S., Hammond, N., & Treasure, J. (2006). Aftercare Intervention Through Text Messaging in the	Health	Self-Report	Bulemia intervention

Treatment of Bulimia Nervosa - Feasibility Pilot. *International Journal of Eating Disorders, 39,* 633–638. doi:10.1002/eat			
Rönkä, A., Malinen, K., Jokinen, K., & Häkkinen, S. (n.d.). A mobile-assisted working model for supporting daily family life: A pilot study. The Family Journal., 1–25.	Health	Self-Report	Feedback on previous mobile intervention
Rönkä, A., Malinen, K., Kinnunen, U., Tolvanen, A., & Lämsä, T. (2010). Capturing daily family dynamics via text messages: development of the mobile diary. *Community, Work and Family, 13*(1), 5–21. doi:10.1080/13668800902823581 (two studies)	Psych	Self-Report	Family dynamics
Rubrichi, S., Battistotti, A., & Quaglini, S. (2014). Patients' involvement in e-health services quality assessment: A system for the automatic interpretation of SMS-based patients' feedback. *Journal of biomedical informatics, 51,* 41-48. doi:10.1016/j.jbi.2014.03.003	Health	Self-Report	Outpatient feedback on SMS reminder system (spontaneous, unbidden)
Schembre, S. M., & Yuen, J. (2011). Project TwEATs. A feasibility study testing the use of automated text messaging to monitor appetite ratings in a free-living population. *Appetite, 56*(2), 465–8. doi:10.1016/j.appet.2011.01.014	Health	Self-Report	Hunger tracking
Schnall, R., Okoniewski, A., Tiase, V., Low, A., Rodriguez, M., & Kaplan, S. (2013). Using text messaging to assess adolescents' health information needs: an ecological momentary assessment. *Journal of medical Internet research, 15*(3), e54. doi:10.2196/jmir.2395	Health	Self-Report	Health information needs
Scott, C. W., Mc, U., & Weina, C. O. L. P. J. (2014). Texting Away Malaria: A New Alternative to Directly Observed Therapy. *Military medicine, 178*(2), e255–e259. doi:10.7205/MILMED-D-12-00257	Health	Clinical reporting	Malaria medication adherence
Seidenberg, P., Nicholson, S., Schaefer, M., Semrau, K., Bweupe, M., Masese, N., Bonawitz, R., et al. (2012). Early infant diagnosis of HIV infection in Zambia through mobile phone texting of blood test results. *Bulletin of the World Health Organization, 90*(5), 348–56. doi:10.2471/BLT.11.100032	Health	Clinical reporting	HIV diagnoses tracking
Shapiro, J. R., Bauer, S., Hamer, R. M., Kordy, H., Ward, D., & Bulik, C. M. (2008). Use of text messaging for monitoring sugar-sweetened beverages, physical activity, and screen time in children: a pilot study. *Journal of nutrition education and behavior, 40*(6), 385-391. doi:doi:10.1016/j.jneb.2007.09.014	Health	Self-Report	Obesity management
Shapiro, J. R, Bauer, S., Andrews, E., Pisetsky, E., Bulik-Sullivan, B., Hamer, R. M., & Bulik, C. M. (2010). Mobile therapy: Use of text-messaging in the treatment of bulimia nervosa. *The International journal of eating disorders, 43*(6), 513–9. doi:10.1002/eat.20744	Health	Self-Report	Tracking eating in bulemia
Shapiro, J. R, Koro, T., Doran, N., Thompson, S., Sallis, J. F., Calfas, K., & Patrick, K. (2012). Text4Diet: A randomized controlled study using text messaging for weight loss behaviors. *Preventive Medicine, 55*(5), 412–417. doi:10.1016/j.ypmed.2012.08.011	Health	Self-Report	Food diary
Shrewsbury, V., Chou, A., Steinbeck, K., Nguyen, B., Baur, L., Lee, A, & Kornman, K. (2010). Adolescent engagement in additional therapeutic contact for overweight management via short message service and electronic mail: the Loozit study. *Journal of Adolescent Health, 46*(2), S15-S16.	Health	Self-Report	Weight management

Smith, B., Harms, W. D., Burres, S., Korda, H., Rosen, H., & Davis, J. (2012). Enhancing behavioral health treatment and crisis management through mobile ecological momentary assessment and SMS messaging. *Health informatics journal, 18*(4), 294–308. doi:10.1177/1460458212445349	Psych	Self-Report	Post-war soldier psychological health
Smith, G. T. A., & Maeder, A. J. (2010). *Using mobile phones for rapid reporting of zoonotic diseases in rural South Africa.* In Global Telehealth: Selected Papers from Global Telehealth 2010 (GT2010): 15th International Conference of the International Society for Telemedicine and EHealth and 1st National Conference of the Australasian Telehealth Society (Vol. 161, p. 179). IOS Press.	Health	Clinical reporting	Zoonotic disease surveillance
Soh, T. W. (2013). Using SMS technology to verify the safety of seasonal trivalent influenza vaccine for pregnant women in real time. *Medical Journal of Australia, 199*(11), 2012–2013. doi:10.5694/mja13.11120	Health	Self-Report	Influenza vaccination reaction in pregnant woman
Song, H., May, A., Vaidhyanathan, V., Cramer, E. M., Owais, R. W., & McRoy, S. (2013). A two-way text-messaging system answering health questions for low-income pregnant women. *Patient education and counseling, 92*(2), 182–7. doi:10.1016/j.pec.2013.04.016	Health	Call for contact	Pregnancy Information
Song, Z., Foo, M.D., & Uy, M. a. (2008). Mood spillover and crossover among dual-earner couples: a cell phone event sampling study. *The Journal of applied psychology, 93*(2), 443–52. doi:10.1037/0021-9010.93.2.443	Psych	Self-Report	Mood spillover between dual-earner couples
Steinberg, D. M., Levine, E. L., Askew, S., Foley, P., & Bennett, G. G. (2013). Daily text messaging for weight control among racial and ethnic minority women: randomized controlled pilot study. *Journal of medical Internet research, 15*(11), e244. doi:10.2196/jmir.2844	Health	Self-Report	Weight loss
Struthers, J., Irvine, P., & Jackson, C. (2013). Can text messaging be used as an effective method for collecting quality and detailed evaluation data from students on clinical placements? *Medical teacher, 35*(8), 678–83. doi:10.3109/0142159X.2013.801549	Psych	Self-Report	Clinical placement feedback
Suffoletto, B., Kristan, J., Callaway, C., Kraemer, K., & Clark, D. (2011). Patterns of Alcohol Consumption in Young Adults Using Text-Message, AUDIT-C and Timeline Follow-Back Assessments. *Annals of Emergency Medicine, 58*(4), S199–S200. doi:10.1016/j.annemergmed.2011.06.093	Health	Self-Report	Problem drinking
Suffoletto, Brian, Callaway, C., Kristan, J., Kraemer, K., & Clark, D. B. (2012). Text-message-based drinking assessments and brief interventions for young adults discharged from the emergency department. *Alcoholism, clinical and experimental research, 36*(3), 552–60. doi:10.1111/j.1530-0277.2011.01646.x	Health	Self-Report	Problem drinking intervention
Suffoletto, Brian, D, M., Akers, A., Mcginnis, K. A., S, M., Calabria, J., Sc, M., et al. (2013). A Sex Risk Reduction Text-Message Program for Young Adult Females Discharged From the Emergency Department. *Journal of Adolescent Health, 53*(3), 387–393. doi:10.1016/j.jadohealth.2013.04.006	Health	Self-Report	Sexual health information
Suffoletto, Brian, Wagner, A. K., Arenth, P. M., Calabria, J., Kingsley, E., Kristan, J., & Callaway, C. W. (2013). Mobile phone text messaging to assess symptoms after mild traumatic brain injury and provide self-care support: a pilot study. *The Journal of head*	Health	Self-Report	Post-concussion headache symptoms

trauma rehabilitation, 28(4), 302–12. doi:10.1097/HTR.0b013e3182847468			
Swaffield, S., Jull, S., & Ampah-Mensah, A. (2013). Using Mobile Phone Texting to Support the Capacity of School Leaders in Ghana to Practise Leadership for Learning. *Procedia - Social and Behavioral Sciences, 103,* 1295–1302. doi:10.1016/j.sbspro.2013.10.459	Psych	Self-Report	Information sharing
Tomayao, A., Yoon, I. K., Tac-an, I., Macasocol, D., Obidas, D., Ygona, S., Coberly, J., et al. (2012). Implementation of SMS fever surveillance in the Philippines. *International Journal of Infectious Diseases,* 16, e147. doi: 10.1016/j.ijid.2012.05.332	Health	Clinical reporting	Fever disease surveillance
Vahdat, H. L., Engle, K. L. L., Plourde, K. F., Magaria, L., & Olawo, A. (2013). There are some questions you may not ask in a clinic: providing contraception information to young people in Kenya using SMS. *International Journal of Gynecology and Obstetrics, 123*, e2–e6. doi:10.1016/j.ijgo.2013.07.009	Psych	Self-Report	Demographic information for contraceptive information study
Van der Kop, M L, Karanja, S., Thabane, L., Marra, C., & Chung, M. H. (2012). In-Depth Analysis of Patient-Clinician Cell Phone Communication during the WelTel Kenya1 Antiretroviral Adherence Trial. *PLos One, 7*(9), e46033. doi:10.1371/journal.pone.0046033	Health	Self-Report	Healthcare dialogue
Whitford, H. M., Donnan, P. T., Symon, A. G., Kellett, G., Monteith-hodge, E., Rauchhaus, P., & Wyatt, J. C. (2012). Evaluating the reliability, validity, acceptability, and practicality of SMS text messaging as a tool to collect research data: results from the Feeding Your Baby project. *Journal of the American Medical Informatics Association, 19*(5), 744-749. doi:10.1136/amiajnl-2011-000785	Health	Self-Report	Study 1: Infant feeding practises
Yoonessi, A., & Ekhtiari, H. (2013). International Journal of Drug Policy Text messages as a tool for assessing public concern about drug problems. *International Journal of Drug Policy, 24*(6), 624–627. doi:10.1016/j.drugpo.2013.06.002	Health	Call for contact	Public opinion on drug problems
Young, P., Moore, E., Griffiths, G., Raine, R., Stewart, R., Cownie, M., & Frutos-perez, M. (2010). Help is just a text away: The use of short message service texting to provide an additional means of support for health care students during practice placements. *Nurse Education Today, 30*(2), 118–123. doi:10.1016/j.nedt.2009.06.010	Psych	Call for contact	Student questions when on clincial placement
Yun, T., & Arriaga, R. I. (2013). *A Text Message a Day Keeps the Pulmonologist Away.* CHI 2013: changing perspectives (pp. 1769–1778). Paris, France.	Health	Self-Report	Asthma montoring

Note. Papers containing multiple studies are identified after the citation.

Appendix 2 Table 4. *Constituent papers for the prompt to support other modes category.*

Paper	Focus	Prompt	Mode
Ashby, R., Turner, G., Cross, B., Mitchell, N., & Torgerson, D. (2011). A randomized trial of electronic reminders showed a reduction in the time to respond to postal questionnaires. *Journal of clinical epidemiology, 64*(2), 208 – 212. doi:10.1016/j.jclinepi.2010.01.020	Health	SMS and / or email	Postal
Bielli, E., Carminati, F., Capra, S. La, Lina, M., Brunelli, C., & Tamburini, M. (2004). A Wireless Health Outcomes Monitoring System (WHOMS): development and field testing with cancer patients using mobile phones. *BMC Medical Informatics and Decision Making, 13,* 1–13. doi:10.1186/1472-6947-4-7	Health	SMS	Smart phone
Cremers, H.-P., Mercken, L., Crutzen, R., Willems, P., De Vries, H., & Oenema, A. (2014). Do email and mobile phone prompts stimulate primary school children to reuse an Internet-delivered smoking prevention intervention? *Journal of medical Internet research, 16*(3), e86. doi:10.2196/jmir.3069	Health	SMS and / or email	Online
Hofmann, W., & Patel, P. V. (2014). SurveySignal: A Convenient Solution for Experience Sampling Research Using Participants' Own Smartphones. *Social Science Computer Review.* doi:10.1177/0894439314525117	Psych	SMS	Smart phone
Kim, H.-S., & Song, M.-S. (2008). Technological intervention for obese patients with type 2 diabetes. *Applied nursing research: 21*(2), 84–9. doi:10.1016/j.apnr.2007.01.007	Health	SMS	Internet
Kollmann, A., Riedl, M., Kastner, P., Schreier, G., & Ludvik, B. (2007). Feasibility of a Mobile Phone–Based Data Service for Functional Insulin Treatment of Type 1 Diabetes Mellitus Patients. *Journal of Medical Internet Research, 9*(5), e36. doi:10.2196/jmir.9.5.e36	Health	SMS	Smart phone
Kristjánsdóttir, Ó. B., Fors, E. a, Eide, E., Finset, A., Van Dulmen, S., Wigers, S. H., & Eide, H. (2011). Written online situational feedback via mobile phone to support self-management of chronic widespread pain: a usability study of a Web-based intervention. *BMC musculoskeletal disorders, 12*(1), 51. doi:10.1186/1471-2474-12-51	Health	SMS	Online
Kuntsche, E., & Labhart, F. (2012). Investigating the drinking patterns of young people over the course of the evening at weekends. *Drug and alcohol dependence, 124*(3), 319–24. doi:10.1016/j.drugalcdep.2012.02.001	Health	SMS	Online
Kwon, H.S., Cho, J.H., Kim, H.S., Lee, J.H., Song, B.R., Oh, J.A., Han, J.-H., et al. (2004). Development of web-based diabetic patient management system using short message service (SMS). *Diabetes research and clinical practice, 66* Suppl 1, S133–7. doi:10.1016/j.diabres.2003.10.028	Health	SMS	Online
Man, M.-S., Tilbrook, H. E., Jayakody, S., Hewitt, C. E., Cox, H., Cross, B., & Torgerson, D. J. (2011). Electronic reminders did not improve postal questionnaire response rates or response times: a randomized controlled trial. *Journal of clinical epidemiology, 64*(9), 1001–4. doi:10.1016/j.jclinepi.2010.10.013	Health	SMS or email	Postal
Moore, S. C., Crompton, K., Goozen, S. Van, Bree, M. Van Den, Bunney, J., & Lydall, E. (2013). A feasibility study of short message service text messaging as a surveillance tool for alcohol consumption and vehicle for interventions in university students. *BMC Public Health, 13,* 1011. doi:10.1186/1471-2458-13-1011	Health	SMS	Online
Virtanen, V., Sirkia, T., & Jokiranta, V. (2007). Reducing Nonresponse by SMS Reminders in Mail Surveys. *Social Science Computer Review, 25(*3), 384–395. doi:10.1177/0894439307299588 (three studies)	General	SMS	Postal

Note. Papers containing multiple studies are identified after the citation.

Appendix 2 Table 5. *Constituent papers for the interventions and support category.*

Paper	Focus	Type
Adams, W. G. (2012). Text messaging increases receipt of influenza vaccine among low-income, urban children. *The Journal of pediatrics, 161*(3), 568–9. doi:10.1016/j.jpeds.2012.07.009	Health	Reminder (appointment)
Adanikin, A. I., Awoleke, J. O., & Adeyiolu, A. (2014). Role of reminder by text message in enhancing postnatal clinic attendance. *International Journal of Gynecology and Obstetrics. 126*(2), 179-180. doi:10.1016/j.ijgo.2014.02.009	Health	Reminder (appointment)
Agyapong, V., McLoughlin, D. M., & Farren, C. K. (2013). 6-Month Outcomes of a Single Blind Randomised Trial of Supportive Text Messaging for Depression and Comorbid Alcohol Use Disorder. *European Congress of Psychiatry, 28,* 1. doi:10.1016/S0924-9338(13)75859-0	Psych	Information
Agyapong, V., McLoughlin, D., & Farren, C. K. (2012). *Usefulness of supportive text messages to patients with alcohol use disorder and comorbid depression -a single-blind randomised trial.* European Congress of Psychiatry (Vol. 27, p. 1). Elsevier. doi:10.1016/S0924-9338(12)74103-2	Health	Information
Agyapong, V.I.O., Milnes, J., & Farren, C. K. (2013). Supportive text messages for patients with alcohol use disorder and comorbid depression - how useful are they for the patients. *European Congress of Psychiatry, 28,* 1. doi:10.1016/S0924-9338(13)75858-9 (two studies)	Health	Information
Agyapong, Vincent I O, McLoughlin, D. M., & Farren, C. K. (2013). Six-months outcomes of a randomised trial of supportive text messaging for depression and comorbid alcohol use disorder. *Journal of affective disorders, 151*(1), 100–4. doi:10.1016/j.jad.2013.05.058	Psych	Information
Agyapong, Vincent Israel Opoku, Milnes, J., McLoughlin, D. M., & Farren, C. K. (2013). Perception of patients with alcohol use disorder and comorbid depression about the usefulness of supportive text messages. *Technology and health care, 21*(1), 31–9. doi:10.3233/THC-120707	Health	Information
Ahlers-Schmidt, C. R., Chesser, A. K., Nguyen, T., Brannon, J., Hart, T. a, Williams, K. S., & Wittler, R. R. (2012). Feasibility of a randomized controlled trial to evaluate Text Reminders for Immunization Compliance in Kids (TRICKs). *Vaccine, 30*(36), 5305–9. doi:10.1016/j.vaccine.2012.06.058	Health	Reminder (appointment)
Ahlers-schmidt, C. R., Chesser, A., Hart, T., Paschal, A., Nguyen, T., & Wittler, R. R. (2010). Text messaging immunization reminders: Feasibility of implementation with low-income parents. *Preventive Medicine, 50*(5-6), 306–307. doi:10.1016/j.ypmed.2010.02.008	Health	Reminder (appointment)
Ahsan, G. M. T., Addo, I. D., Ahamed, S. I., Petereit, D., Kanekar, S., Burhansstipanov, L., & Krebs, L. U. (2013). *Toward an mHealth Intervention for Smoking Cessation.* Proceedings: Annual International Computer Software and Applications Conference / sponsored by IEEE Computer Society. COMPSAC, (Cdc), 1–12. doi:10.1109/COMPSACW.2013.61	Health	Information
Ali, A., & Abdulkadir, S. (2012). A solution for medical and legal problems arising from forgotten ureteral stents: initial results from a reminder short message service (SMS). *Urological research, 40*(3), 253–258. doi:10.1007/s00240-011-0404-8	Health	Reminder (appointment)
Altuwaijri, M. M., Sughayr, A. M., Hassan, M., & Alazwari, F. M. (2012). The effect of integrating short messaging services' reminders with electronic medical records on non-attendance rates. *Saudi medical journal, 33*(2), 193–6.	Health	Reminder (appointment)
Ammassari, A., Trotta, M. P., Shalev, N., Tettoni, M. C., Maschi, S., Di Sora, F., Orofino, G., et al. (2011). Timed short messaging service improves adherence and virological outcomes in HIV-1-infected patients with suboptimal adherence to antiretroviral therapy. *Journal of acquired immune deficiency syndromes, 58*(4), e113–e115. doi:10.1097/QAI.0b013e3182359d2a	Health	Reminder (appointment)

Antypas, K., & Wangberg, S. C. (2012). E-Rehabilitation - an Internet and mobile phone based tailored intervention to enhance self-management of cardiovascular disease: study protocol for a randomized controlled trial. *BMC cardiovascular disorders, 12*(1), 50. doi:10.1186/1471-2261-12-50	Health	Information
Armstrong, A., Kimball, A., Watson, A., Kvedar, J., & Kazanis, M. (2009). A randomized, controlled trial evaluating adherence to sunscreen using electronic monitoring and text message reminders. *Archives of dermatology, 60*(3), AB88.	Health	Reminder (action)
Armstrong, A., Watson, A., Makredes, M., Frangos, J. E., Kimball, A. B., & Kvedar, J. C. (2014). Text-Message Reminders to Improve Sunscreen Use: a randomized, controlled trial using electronic monitoring. *Archives of Dermatology, 145*(11), 1230–1236. doi:10.1001/archdermatol.2009.269	Health	Reminder (action)
Arora, S. (2014). *Text message program improves outcomes, decreases ED utilization among ED patients with poorly controlled diabetes.* ED management, 20 – 23.	Health	Information
Arora, S., Peters, A. L., Burner, E., Lam, C. N., & Menchine, M. (2013). Trial to Examine Text Message-Based mHealth in Emergency Department Patients With Diabetes (TExT-MED): A Randomized Controlled Trial. *Annals of emergency medicine, 63*(6), 15–20. doi:10.1016/j.annemergmed.2013.10.012	Health	Information
Årsand, E., Frøisland, D. H., Skrøvseth, S. O., Chomutare, T., Tatara, N., Hartvigsen, G., & Tufano, J. T. (2012). Mobile health applications to assist patients with diabetes: lessons learned and design implications. *Journal of diabetes science and technology, 6*(5), 1197–206.	Health	Information
Bailey, S. M., Scalley, B. D., & Gilles, M. T. (2014). Text 2 treat - using SMS to recall clients for treatment. *International journal of STD & AIDS, 25*(14), 1038-1040. doi:10.1177/0956462414530108	Health	Reminder (appointment)
Battistotti, A., Quaglini, S., & Cuoco, E. (2006). Reducing dropouts in outpatient care through an SMS-based system. *Studies in health technology and informatics, 124*, 935-940.	Health	Reminder (appointment)
Bediang, G., Stoll, B., Elia, N., Abena, J.L., Nolna, D., Chastonay, P., & Geissbuhler, A. (2014). SMS reminders to improve the tuberculosis cure rate in developing countries (TB-SMS Cameroon): a protocol of a randomised control study. *Trials, 15*(1), 35. doi:10.1186/1745-6215-15-35	Health	Reminder (appointment)
Benhamou, P. Y., Melki, V., Boizel, R., Perreal, F., Quesada, J. L., Bessieres-Lacombe, S., Bosson, J. L., et al. (2007). One-year efficacy and safety of Web-based follow-up using cellular phone in type 1 diabetic patients under insulin pump therapy: the PumpNet study. *Diabetes and Metabolism, 33*(3), 220 – 226. doi:10.1016/j.diabet.2007.01.002	Health	Information
Bennett, D., & Emberson, J. R. (2011). Text messaging in smoking cessation: the txt2stop trial. *Lancet, 378*(9785), 6–7. doi:10.1016/S0140-6736(11)60882-9	Health	Information
Berrouiguet, S., Gravey, M., Le Galudec, M., Alavi, Z., & Walter, M. (2014). Post-acute crisis text messaging outreach for suicide prevention: A pilot study. *Psychiatry Research, 217*(3), 154-157. doi:10.1016/j.psychres.2014.02.034	Psych	Information
Berry, D. C., Neal, M., Hall, E. G., Schwartz, T., Verbiest, S., Bonuck, K., Goodnight, W., et al. (2013). Rationale, design, and methodology for the optimizing outcomes in women with gestational diabetes mellitus and their infants study. *BMC pregnancy and childbirth, 13*(1), 184. doi:10.1186/1471-2393-13-184	Health	Information
Bicard, D. F., Lott, V., Mills, J., Bicard, S., & Baylot-Casey, L. (2012). Effects of text messaged self-monitoring on class attendance and punctuality of at-risk college student athletes. *Journal of applied behavior analysis, 45*(1), 205–10. doi:10.1901/jaba.2012.45-205	Health	Reminder (appointment)
Bigelow, K. M., Carta, J. J., & Lefever, J. B. (2008). Txt u ltr: Using cellular phone technology to enhance parenting intervention for families at risk for neglect. *Child maltreatment, 13*(4), 362 – 367. doi:10.1177/1077559508320060	Health	Information

Bigna, J. J. R., Kouanfack, C., Noubiap, J. J. N., Plottel, C. S., & Koulla-Shiro, S. (2013). A randomized blinded controlled trial of mobile phone reminders on the follow-up medical care of HIV-exposed and HIV-infected children in Cameroon: study protocol (MORE CARE). *Trials, 14*(1), 313. doi:10.1186/1745-6215-14-313	Health	Reminder (appointment)
Bilardi, J. E., Fairley, C. K., Hopkins, C. a, Hocking, J. S., Sze, J. K., & Chen, M. Y. (2010). Let Them Know: evaluation of an online partner notification service for chlamydia that offers E-mail and SMS messaging. *Sexually transmitted diseases, 37*(9), 563–5. doi:10.1097/OLQ.0b013e3181d707f1	Health	Reminder (appointment)
Bin-Abbas, B., Jabbari, M., Al-Fares, A., El-Dali, A., & Al-Orifi, F. (2014). Effect of mobile phone short text messages on glycaemic control in children with type 1 diabetes. *Journal of telemedicine and telecare, 20*(3), 153-156.	Health	Information
Bockting, C. L. H., Kok, G. D., Van der Kamp, L., Smit, F., Van Valen, E., Schoevers, R., Van Marwijk, H., et al. (2011). Disrupting the rhythm of depression using Mobile Cognitive Therapy for recurrent depression: randomized controlled trial design and protocol. *BMC psychiatry, 11*(1), 12. doi:10.1186/1471-244X-11-12	Psych	Information
Boker, A., Armstrong, A., Feetham, Jill, H., Jacobe, H., & Purcell, P. (2012). A multicenter, randomized, controlled, evaluator-blinded pilot study to evaluate the effect of automated text message reminders on patient compliance with topical medications and its efficacy on disease control in adolescents and adults with mild to moder. *Journal of the American Academy of Dermatology* (66). doi:10.1016/j.jaad.2011.11.352	Health	Reminder (appointment)
Boker, A., Feetham, H. J., Armstrong, A., Purcell, P., & Jacobe, H. (2012). Do automated text messages increase adherence to acne therapy? Results of a randomized, controlled trial. *Journal of the American Academy of Dermatology, 67*(6), 1136–42. doi:10.1016/j.jaad.2012.02.031	Health	Reminder (action)
Bos, A., Hoogstraten, J., & Prahl-Andersen, B. (2005). Failed appointments in an orthodontic clinic. *American journal of orthodontics and dentofacial orthopedics, 127*(3), 355–7. doi:10.1016/j.ajodo.2004.11.014	Health	Reminder (appointment)
BouHaidar, C. (n.d.). *Text messaging as adjunct to community based weight management program.* Virginia Commonwealth University, United States of America.	Health	Information
Bourne, C., Knight, V., Guy, R., Wand, H., Lu, H., & McNulty, a. (2011). Short message service reminder intervention doubles sexually transmitted infection/HIV re-testing rates among men who have sex with men. *Sexually transmitted infections, 87*(3), 229–31. doi:10.1136/sti.2010.048397	Health	Reminder (appointment)
Boyd, J., Harper, C., & Thomas, P. (2013). Text messages improve pain management post-discharge from the paediatric emergency department. *African Journal of Emergency Medicine, 3*(4), S4–S5. doi:10.1016/j.afjem.2013.08.007	Health	Reminder (appointment)
Bozkurt, Y., Sancaktutar, A. a., Atar, M., Penbegul, N., Soylemez, H., Akay, A., Yýldýrým, K., et al. (2011). A New Recommendation At the Following of Uro-Oncological Tumors: Reminder Short Message Service (SMS). *European Urology Supplements, 10*(9), 604–605. doi:10.1016/S1569-9056(11)61561-3	Health	Reminder (appointment)
Bramley, D., Riddell, T., Whittaker, R., Corbett, T., Lin, R., Wills, M., Jones, M., et al. (2005). Smoking cessation using mobile phone text messaging is as effective in Maori as non-Maori. *The New Zealand medical journal, 118*(1216), 1–10.	Health	Information
Brannan, S. O., Dewar, C., Taggerty, L., & Clark, S. (2011). The effect of short messaging service text on non-attendance in a general ophthalmology clinic. *Scottish Medical Journal, 56*(3), 148–150. doi:10.1258/smj.2011.011112.	Health	Reminder (appointment)
Branson, C. E., Clemmey, P., & Mukherjee, P. (2013). Text Message Reminders to Improve Outpatient Therapy Attendance Among Adolescents: A Pilot Study. *Psychological services, 10*(3), 298–303. doi:10.1037/a0026693	Psych	Reminder (appointment)

Brendryen, H., & Kraft, P. (2008). Happy ending: a randomized controlled trial of a digital multi-media smoking cessation intervention. *Addiction, 103*(3), 478–84; discussion 485–6. doi:10.1111/j.1360-0443.2007.02119.x	Health	Information
Britto, M. T., Munafo, J. K., Schoettker, P. J., Vockell, A.-L. B., Wimberg, J. a, & Yi, M. S. (2012). Pilot and feasibility test of adolescent-controlled text messaging reminders. *Clinical pediatrics, 51*(2), 114–21. doi:10.1177/0009922811412950	Health	Reminder (action)
Brown, L., Copas, A., Stephenson, J., Gilleran, G., & Ross, J. D. C. (2008). Preferred options for receiving sexual health screening results: a population and patient survey. *International journal of STD & AIDS, 19*(3), 184–7. doi:10.1258/ijsa.2007.007172	Health	Information
Brown, O. N., O'Connor, L. E., & Savaiano, D. (2014). Mobile MyPlate: A Pilot Study Using Text Messaging to Provide Nutrition Education and Promote Better Dietary Choices in College Students. *Journal of American college health, 65*(2), 320-327. doi:10.1080/07448481.2014.899233	Health	Information
Buis, L. R., Hirzel, L., Turske, S. a, Des Jardins, T. R., Yarandi, H., & Bondurant, P. (2013). Use of a text message program to raise type 2 diabetes risk awareness and promote health behavior change (part I): assessment of participant reach and adoption. *Journal of medical Internet research, 15*(12), e281. doi:10.2196/jmir.2928	Health	Information
Buller, D. B., Borland, R., Bettinghaus, E. P., Shane, J. H., & Zimmerman, D. E. (2014). Randomized trial of a smartphone mobile application compared to text messaging to support smoking cessation. *Telemedicine journal and e-health, 20*(3), 206–14. doi:10.1089/tmj.2013.0169	Health	Information
Burton, J., Brook, G., McSorley, J., & Murphy, S. (2014). The utility of short message service (SMS) texts to remind patients at higher risk of STIs and HIV to reattend for testing: a controlled before and after study. *Sexually transmitted infections, 90*(1), 11–3. doi:10.1136/sextrans-2013-051228	Health	Reminder (appointment)
Car, J., Ng, C., Atun, R., & Card, A. (2008). SMS Text Message Healthcare Appointment Reminders in England. *Journal of Ambulatory Care Management, 31*(3), 216 – 219. doi:10.1097/01.JAC.0000324666.98777.6d	Health	Reminder (appointment)
Castaño, P., Bynum, J., & Westhoff, C. (2011a). Cell phone use characteristics and oral contraceptive continuation in a text message trial. *Contraception, 84*(3), 333. doi:10.1016/j.contraception.2011.05.116	Health	Information
Castaño, P., Bynum, J., & Westhoff, C. (2011b). Six-month oral contraceptive continuation in a randomized trial of a daily text message intervention. *Contraception, 84*(3), 306. doi:10.1016/j.contraception.2011.05.138	Health	Information
Castaño, P., Martínez, R. a., Lara, M., & Westhoff, C. L. (2010). Txt Now 2 Decrease Pregnancies L8r: a randomized control trial to evaluate the effect of daily educational text messages on oral contraceptive continuation in young urban women. *Contraception, 82*(2), 189. doi:10.1016/j.contraception.2010.04.046	Health	Information
Chai, S. J., Tan, F., Ji, Y., Wei, X., Li, R., & Frost, M. (2013). Community-level text messaging for 2009 H1N1 prevention in China. *American journal of preventive medicine, 45*(2), 190–6. doi:10.1016/j.amepre.2013.03.014	Health	Information
Chang, L. W., Kagaayi, J., Arem, H., Nakigozi, G., Ssempijja, V., Serwadda, D., Quinn, T. C., et al. (2011). Impact of a mHealth intervention for peer health workers on AIDS care in rural Uganda: a mixed methods evaluation of a cluster-randomized trial. *AIDS and behavior, 15*(8), 1776–84. doi:10.1007/s10461-011-9995-x	Health	Information
Chang, M.J. (2008). *The effectiveness of mobile short message service technology to support vocabulary learning*. University of northern Colorado, United States of America.	General	Information
Chen, H., Mishara, B. L., & Liu, X. X. (2010). A pilot study of mobile telephone message interventions with suicide attempters in China. *Crisis, 31*(2), 109–12. doi:10.1027/0227-5910/a000017	Psych	Information

Chen, Z.-W., Fang, L.-Z., Chen, L.-Y., & Dai, H.-L. (2008). Comparison of an SMS text messaging and phone reminder to improve attendance at a health promotion center: a randomized controlled trial. *Journal of Zhejiang University, 9*(1), 34–8. doi:10.1631/jzus.B071464	Health	Reminder (appointment)
Cheng, P., Wu, T. L., Shaw, S., Chueh, H., Lin, C., Hsu, J., Hsieh, T., et al. (2008). Anxiety levels in women undergoing prenatal maternal serum screening for Down syndrome: the effect of a fast reporting system by mobile phone short-message service. *Prenatal Diagnosis, 28*, 417–421. doi:10.1002/pd.1988	Psych	Information
Chi, B. H., & Stringer, J. S. a. (2010). Mobile phones to improve HIV treatment adherence. *Lancet, 376*(9755), 1807–8. doi:10.1016/S0140-6736(10)62046-6	Health	Reminder (action)
Chib, A., Wilkin, H., & Hoefman, B. (2013). Vulnerabilities in mHealth implementation: a Ugandan HIV/AIDS SMS campaign. *Global health promotion, 20*(1), 26–32. doi:10.1177/1757975912462419	Health	Information
Cochrane, J. E., Lowbridge, C., Maywood, P., & Conaty, S. J. (2009). SMS text messaging for contact follow-up in invasive meningococcal disease. *The Medical journal of Australia, 190*(5), 282–3.	Health	Information
Cocosila, M., Archer, N., Haynes, R. B., & Yuan, Y. (2009). Can wireless text messaging improve adherence to preventive activities? Results of a randomised controlled trial. *International journal of medical informatics, 78*(4), 230–8. doi:10.1016/j.ijmedinf.2008.07.011	Health	Reminder (action)
Cocosila, M., Ph, D., Archer, N., & Yuan, Y. (2008). Would People Pay for Text Messaging Health Reminders? *Telemedicine and e-Health, 14*(10), 1091–1095. doi:10.1089/tmj.2008.0047	Health	Reminder (action)
Cocsila, M. (2007). *User acceptance of wireless text messaging in telehealth: a case for adherence.* McMaster University.	Health	Reminder (action)
Cohen, C. E., Coyne, K. M., Mandalia, S., Waters, M., & Sullivan, a K. (2008). Time to use text reminders in genitourinary medicine clinics. *International journal of STD & AIDS, 19*(1), 12–3. doi:10.1258/ijsa.2007.007149	Health	Reminder (appointment)
Contreras, M., De la Figuera von Wichmann, M., Guillén, G. V, Ylla-Catalá, A., Figueras, M., Balaña, M., & Naval, J. (2004). Effectiveness of an intervention to provide information to patients with hypertension as short text messages and reminders sent to their mobile phone (HTA-Alert). *Aten Primaria, 34*(8), 399 – 405.	Health	Reminder (action)
Coomes, C. M., Lewis, M. a, Uhrig, J. D., Furberg, R. D., Harris, J. L., & Bann, C. M. (2012). Beyond reminders: a conceptual framework for using short message service to promote prevention and improve healthcare quality and clinical outcomes for people living with HIV. *AIDS care, 24*(3), 348–57. doi:10.1080/09540121.2011.608421	Health	Information
Cornelius, J. B., Cato, M. G., Toth, J. L., Bard, P. M., Moore, M. W., & White, A. (2012). Following the trail of an HIV-prevention Web site enhanced for mobile cell phone text messaging delivery. *The Journal of the Association of Nurses in AIDS Care, 23*(3), 255–9. doi:10.1016/j.jana.2011.03.002	Health	Information
Cornelius, J. B., Cato, M., Lawrence, J. S., Boyer, C. B., & Lightfoot, M. (2011). Development and pretesting multimedia HIV-prevention text messages for mobile cell phone delivery. *The Journal of the Association of Nurses in AIDS Care, 22*(5), 407–13. doi:10.1016/j.jana.2010.11.007	Health	Information
Cornelius, J. B., Dmochowski, J., Boyer, C., St Lawrence, J., Lightfoot, M., & Moore, M. (2013). Text-messaging-enhanced HIV intervention for African American adolescents: a feasibility study. *The Journal of the Association of Nurses in AIDS Care, 24*(3), 256–67. doi:10.1016/j.jana.2012.06.005	Health	Information
Crisp, M. S. (2009). *Modernizing school communication systems: using text messaging to improve student academic performance.* Oregon state university, United States of America.	General	Reminder (action)

Culley, C., & Evans, J. J. (2010). SMS text messaging as a means of increasing recall of therapy goals in brain injury rehabilitation: a single-blind within-subjects trial. *Neuropsychological rehabilitation, 20*(1), 103–19. doi:10.1080/09602010902906926	Health	Information
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Sancaktutar, a. a., Bozkurt, Y., Penbegül, N., Tepeler, A., Atar, M., Yildirim, K., Sancaktutar, M., et al. (2010). A Solution for Medical and Legal Problems Arising From Forgotten Ureteral Stents: Reminder Short Message Service (SMS). *European Urology Supplements, 9*(6), 610. doi:10.1016/S1569-9056(10)61499-6	General	Reminder (action)
Scanaill, C. N., Ahearne, B., & Lyons, G. M. (2006). Long-term telemonitoring of mobility trends of elderly people using SMS messaging. *IEEE transactions on information technology in biomedicine, 10*(2), 412–3.	Health	Other
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Seon Choung, R., Young Kim, S., Jin Hyun, J., Woo Jung, S., Seol Koo, J., Woo Lee, S., & Hyun Choi, J. (2013). Effect of Education Using Text Message and Dietary Intake on Bowel Preparation for Colonoscopy. *Gastrointestinal Endoscopy, 77*(5), AB514. doi:10.1016/j.gie.2013.03.844	Health	Reminder (appointment)
Sharma, R., Hebbal, M., Ankola, A. V, & Murugabupathy, V. (2011). Mobile-phone text messaging (SMS) for providing oral health education to mothers of preschool children in Belgaum City. *Journal of telemedicine and telecare, 17*(8), 432–436. doi:10.1258/jtt.2011.110416	Health	Information
Shaw, R. J., Bosworth, H. B., Silva, S. S., Lipkus, I. M., Davis, L. L., Ronald, S. S., & Johnson, C. M. (2013). Mobile health messages help sustain recent weight loss. *The American journal of medicine, 126*(11), 1002-1009. doi:http://dx.doi.org/10.1016/j.amjmed.2013.07.001	Health	Information
Shaw, Ryan Jeffrey. (2012). *A mobile health intervention to sustain recent weight loss.* Duke University, United States of America.	Health	Information
Shetty, A. S., Chamukuttan, S., Nanditha, A., Raj, R. K. C., & Ramachandran, A. (2011). Reinforcement of Adherence to Prescription Recommendations in Asian Indian Diabetes Patients. *Journal of the Association of Physicians of India, 59,* 711–714.	Health	Reminder (action)
Shi, H.-J., Jiang, X.-X., Yu, C.-Y., & Zhang, Y. (2013). Use of mobile phone text messaging to deliver an individualized smoking behaviour intervention in Chinese adolescents. *Journal of telemedicine and telecare 19*(5), 282-287. doi:10.1177/1357633X13495489	Health	Information
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Spark, L., Fjeldsoe, B., Reeves, M., & Eakin, E. (2012). Acceptability of a text message-delivered physical activity and dietary behavior change intervention in breast cancer survivors. *Journal of Science and Medicine in Sport, 15,* 127 – 187. doi:http://dx.doi.org/10.1016/j.jsams.2012.11.428	Health	Information

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Stockwell, M. S., Kharbanda, E. O., Martinez, R. A., Lara, M., Vawdrey, D., Natarajan, K., & Rickert, V. I. (2012). Text4Health: impact of text message reminder-recalls for pediatric and adolescent immunizations. *American journal of public health, 102*(2), e15–21. doi:10.2105/AJPH.2011.300331	Health	Reminder (appointment)
Stockwell, M. S., Westhoff, C., Kharbanda, E. O., Vargas, C. Y., Camargo, S., Vawdrey, D. K., & Castaño, P. M. (2014). Influenza vaccine text message reminders for urban, low-income pregnant women: a randomized controlled trial. *American journal of public health, 104*, 7–12. doi:10.2105/AJPH.2013.301620	Health	Reminder (appointment)
Strandbygaard, U., Thomsen, S. F., & Backer, V. (2010a). A daily SMS reminder increases adherence to asthma treatment: A three-month follow-up study. *Respiratory Medicine, 104*(2), 166–171. doi:10.1016/j.rmed.2009.10.003	Health	Reminder (action)
Suomi, R., Serkkola, A., & Mikkonen, M. (2007). GSM-Based SMS time reservation system for dental care. *International journal of technology and human interaction, 3*, 54–68.	Health	Reminder (appointment)
Taylor, N., Bottrell, J., Lawler, K., & Benjamin, D. (2012). Mobile telephone short message service reminders can reduce nonattendance in physical therapy outpatient clinics: a randomized controlled trial. *Archives of physical medicine and rehabilitation, 93*(1), 21-26. doi:10.1016/j.apmr.2011.08.007	Health	Reminder (appointment)
Theiler, R., Alon, E., Brugger, S., Ljutow, A., Mietzsch, T., Müller, D., Ott, A., et al. (2007). Evaluation of a standardized internet-based and telephone-based patient monitoring system for pain therapy with transdermal fentanyl. *The Clinical journal of pain, 23*(9), 804–11. doi:10.1097/AJP.0b013e3181565d04	Health	Other
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Ting, T. v, Kudalkar, D., Nelson, S., Cortina, S., Pendl, J., Budhani, S., Neville, J., et al. (2012). Usefulness of Cellular Text Messaging for Improving Adherence Among Adolescents and Young Adults with Systemic Lupus Erythematosus. *The Journal of Rhemotology, 39*(1), 179 – 174. doi:10.3899/jrheum.110771	Health	Reminder (action)
Välimäki, M., Hätönen, H., & Adams, C. E. (2012). Mobile.net: Mobile Telephone Text Messages to Encourage Adherence to Medication and to Follow up With People With Psychosis: Methods and Protocol for a Multicenter Randomized Controlled Two-Armed Trial. *JMIR Research Protocols, 1*(2), e8. doi:10.2196/resprot.2136	Psych	Information
Van Mierlo, T., Fournier, R., Jean-charles, A., Hovington, J., Ethier, I., & Selby, P. (2014). I ' ll Txt U if I Have a Problem?: How the Socie Canadienne du Cancer in Quebec Applied Behavior- Change Theory , Data Mining and Agile Software Development to Help Young Adults Quit Smoking. *PLoS ONE, 9*(3). doi:10.1371/journal.pone.0091832	Health	Information
Van Velthoven, M. H., Majeed, A., & Car, J. (2012). Text4baby - national scale up of an mHealth programme. Who benefits? *Journal of the royal society of medicine, 105*(11), 452 – 453. doi:10.1258/jrsm.2012.120176	Health	Information

Velthoven, M. H. Van, Li, Y., Wang, W., Du, X., Chen, L., Wu, Q., Zhang, Y., et al. (2013). mHealth Series: Factors influencing sample size calculations for mHealth – based studies – A mixed methods study in rural China. *Journal of global health, 3*(2). doi:10.7189/jogh.03.020404	Health	Other
Vervloet, M., Dijk, L. Van, Bakker, D. H. De, Souverein, P. C., Aarle, M. C. W. Van, Hoek, L. S. Van Der, Bouvy, M. L., et al. (2014). Short- and long-term effects of real-time medication monitoring with short messaging service (SMS) reminders for missed doses on the refill adherence of people with Type 2 diabetes: evidence from a randomized controlled trial. *Diabetic Medicine,* e12439. doi:10.1111/dme.12439	Health	Reminder (action)
Vervloet, M., Dijk, L. Van, Vlijmen, B. Van, Wingerden, P. Van, Bouvy, M. L., & Bakker, D. H. De. (2012). SMS reminders improve adherence to oral medication in type 2 diabetes patients who are real time electronically. *International Journal of Medical Informatics, 81*(9), 594–604. doi:10.1016/j.ijmedinf.2012.05.005	Health	Reminder (action)
Vest, J. R., Issel, L. M., & Lee, S. (2014). Experience of using information systems in public health practice: findings from a qualitative study. *Online journal of public health informatics, 5*(3), 227. doi:10.5210/ojphi.v5i3.4847	Health	Other
Vidrine, D. J., Fletcher, F. E., Danysh, H. E., Marani, S., Vidrine, J. I., Cantor, S. B., & Prokhorov, A. V. (2012). A randomized controlled trial to assess the efficacy of an interactive mobile messaging intervention for underserved smokers: Project ACTION. *BMC Public Health, 12*(1), 1. doi:10.1186/1471-2458-12-696	Health	Information
Vilella, A., Bayas, J.M., Diaz, M.T., Guinovart, C., Diez, C., Simo, D., Munoz, A., et al. (2004). The role of mobile phones in improving vaccination rates in travelers. *Preventive Medicine, 38*, 503–509. doi:10.1016/j.ypmed.2003.12.005	Health	Reminder (appointment)
Volcke, D., Snoeck, P., Festjens, T., Kowalski, J., Jones, R., & Hoorde, S. Van. (2007). Feasibility and acceptability of short message service (SMS) text messaging to support adherence in patients receiving quetiapine: A pilot study. *European Psychiatry 22*, 294–295.	Psych	Reminder (action)
Vuong, N. K., Goh, S. G. A., Chan, S., & Lau, C. T. (2013). *A Mobile-Health Application to Detect Wandering Patterns of Elderly People in Home Environment.* 35th Annual International Conference of the IEEE EMBS (pp. 6748–6751). Osaka.	Health	Other
Wakadha, H., Chandir, S., Victor, E., Rubin, A., Obor, D., Levine, O. S., Gibson, D. G., et al. (2013). The feasibility of using mobile-phone based SMS reminders and conditional cash transfers to improve timely immunization in rural Kenya. *Vaccine, 31*(6), 987–993. doi:10.1016/j.vaccine.2012.11.093	Health	Reminder (appointment)
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Wilkins, A., & Mak, D. B. (2007). Sending out an SMS: an impact and outcome evaluation of the Western Australian Department of Health's 2005 chlamydia campaign. *Health promotion journal of Australia, 18*(2), 113–121.	Health	Information

Wizner, B., Gaciong, Z., Narkiewicz, K., Szykula, D., & Grodzicki, T. (2010). High risk patients benefit most from the SMS-based intervention. *Journal of hypertension, 28*, e329. doi:10.1097/01.hjh.0000379198.08164.51	Health	Reminder (action)
Wong, C. K. H., Fung, C. S. C., Siu, S. C., Lo, Y. Y. C., Wong, K. W., Fong, D. Y. T., & Lam, C. L. K. (2013). A short message service (SMS) intervention to prevent diabetes in Chinese professional drivers with pre-diabetes: A pilot single-blinded randomized controlled trial. *Diabetes Research and Clinical Practice, 102*(3), 158–166. doi:10.1016/j.diabres.2013.10.002	Health	Information
Woods, D., Attwell, A., Ross, K., & Theron, G. (2012). Text messages as a learning tool for midwives. *South African Medical journal, 102*(2), 100–101.	General	Information
Woolford, S. J., Clark, S. J., Strecher, V. J., & Resnicow, K. (2010). Tailored mobile phone text messages as an adjunct to obesity treatment for adolescents. *Journal of telemedicine and telecare, 16*(8), 458-461.	Health	Information
Woolford, S. J., Clark, S. J., Strecher, V. J., & Resnicow, K. (2012). Tailored mobile phone text messages as an adjunct to obesity treatment for adolescents. *Journal of telemedicine and telecare, 16*(8), 458–461. doi:10.1258/jtt.2010.100207.Tailored	Health	Information
Wu, C. J., Sung, H., Chang, A. M., Atherton, J., Kostner, K., Courtney, M., & Mcphail, S. M. (2013). Protocol for a randomised blocked design study using telephone and text-messaging to support cardiac patients with diabetes: a cross cultural international collaborative project. *BMC Health Services Research, 13*(1), 1. doi:10.1186/1472-6963-13-402	Health	Information
Ybarra, M. L., Holtrop, J. S., & Bosi, A. T. B. (2013). Feasibility and Acceptability of a Text Messaging - Based Smoking Cessation Program in Ankara , Turkey. *Journal of Health Communication: International Perspectives, 18*(8), 37–41. doi:10.1080/10810730.2012.757399	Health	Information
Ybarra, M. L., Holtrop, J. S., Bosi, A. T. B., & Emri, S. (2012). Design Considerations in Developing a Text Messaging Program Aimed at Smoking Cessation. *Journal of medical Internet research, 14*(14), 4. doi:10.2196/jmir.2061	Health	Information
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Ybarra, M., Ph, D., Bosi, A. T. B., Korchmaros, J., & Emri, S. (2012). A Text Messaging-Based Smoking Cessation Program for Adult Smokers?: Randomized Controlled Trial. *Journal of medical Internet research, 14*(6), 1–14. doi:10.2196/jmir.2231	Health	Information
Yoon, K., & Kim, H. (2008). A short message service by cellular phone in type 2 diabetic patients for 12 months. *Diabetes research and clinical practice, 79*, 256–261. doi:10.1016/j.diabres.2007.09.007	Health	Information
Youssef, A., Alharthi, H., Khaldi, O. Al, Alnaimi, F., Alsubaie, N., & Alfariss, N. (2014). Effectiveness of text message reminders on nonattendance of outpatient clinic appointments in three different specialties: A randomized controlled trial in a Saudi Hospital. *Journal of Taibah University Medical Sciences, 9*(1), 23–29. doi:10.1016/j.jtumed.2013.10.001	Health	Reminder (appointment)
Yuan, M. J., Hébert, E. T., Johnson, R. K., Long, J., Vandewater, E. A., & Vickers, A. J. (2012). A Personalized Automated Messaging System to Improve Adherence to Prostate Cancer Screening: Research Protocol. *JMIR Research Protocols., 1*(2), e20.	Health	Reminder (appointment)
Yun, T. (2012). *Using ubiquitous communication technology to improve pediatric asthma management.* Georgia Institute of Technology, United States of America.	Health	Information
Zhang, H., Song, W., & Burston, J. (2011). Reexamining the effectiveness of vocabulary learning via mobile phones. *The turkish online journal of educational technology, 10*(3), 203–215.	General	Information

Zolfaghari, Mirta, Mousavifar, S. A., & Haghani, H. (2012). Mobile phone text messaging and Telephone follow-up in type 2 diabetic patients for 3 months: a comparative study. *Journal of diabetes & metabolic disorders, 11*(7).	Health	Information
Zolfaghari, Mitra, Mousavifar, S. A., Pedram, S., & Haghani, H. (2012). The impact of nurse short message services and telephone follow-ups on diabetic adherence: which one is more effective? *Journal of clinical nursing, 21*, 1922–1931. doi:10.1111/j.1365-2702.2011.03951.x	Health	Information
Zurovac, D., Sudoi, R. K., Akhwale, W. S., Ndiritu, M., Hamer, D. H., Rowe, A. K., & Snow, R. W. (2011). The effect of mobile phone text-message reminders on Kenyan health workers' adherence to malaria treatment guidelines: a cluster randomised trial. *The Lancet, 378*(9793), 795–803. doi:10.1016/S0140-6736(11)60783-6	Health	Reminder (appointment)

Note. Papers containing multiple studies are identified after the citation.

Appendix 3: Meta-Analysis Tables (Chapter 4)

Paper	RR	Location	Topic	n	Mean Age	% Female	Sample	Salient	Sensitive	Type	Focus	Pre-notification	Personalisation	Follow-up	Physical	Incentive	Reimbursement	Choice	n Questions	Fixed?	Course	*n* Occasions	Frequency	Other Modes	Schedule	Duration (days)
Aguilera and Muñoz (2011)	64	United States	Depression	12	52.3	50	spec	y	n	exp	self	-	-	y	-	mo	dev	-	3	y	rs	120	daily	-	ra	60
Ainsworth et al. (2013)	56	United Kingdom	Schizophrenia	24	-	21	spec	y	y	exp	self	y	-	y	y	mo	yes	-	-	-	rd	24	daily	s	ra	6
Alfven (2010)	83	Sweden	Pain	15	12	-	child	y	n	exp	self	-	-	-	y	-	-	-	3	y	rs	42	daily	-	-	7
Anhoj and Moldrup (2009)	69	Denmark	Asthma	12	38.5	50	spec	y	n	beh	self	-	-	-	-	mo	-	-	3	y	rs	63	daily	-	fix	63
Axén, Bergström, and Bodin (2013)	83	Sweden	Pain	244	44	48	spec	y	n	exp	self	-	-	-	-	-	-	-	1	y	rs	24	wkly	-	fix	180
Axén, Bodin, Bergström, et al. (2012)	83	Sweden	Back pain	244	44	48	spec	y	n	exp	self	-	-	y	-	-	-	-	1	y	rs	6	wkly	-	fix	42
Axén, Bodin, Kongsted, et al. (2012)	-	-	Back pain	-	-	-	-	y	n	exp	self	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Baron, Goutard, Nguon, and Tarantola (2013)	72	Cambodia	Medical treatment monitoring	184	26.9	53	spec	n	n	exp	self	-	-	y	y	-	-	-	1	-	on	1	once	-	-	-
Batch et al. (2014)	-	United States	other	-	-	-	-	n	y	beh	self	-	-	-	-	-	-	-	3	-	-	-	-	-	-	-
Bauer, De Niet, Timman, and Kordy (2010)	67	Germany	Obesity and weight	49	10	47	child	n	y	beh	self	-	-	-	-	-	-	-	-	-	-	-	wkly	-	-	36
Bauer et al. (2010)	-	Germany	Eating disorder	82	29.9	100	spec	y	n	beh	self	-	-	-	-	-	-	-	3	y	rs	16	wkly	-	fix	112
Bauer, Percevic, Okon, Meermann, and Kordy (2003)	-	Germany	Eating disorder	-	-	-	spec	y	n	beh	self	-	-	-	-	-	-	-	3	-	-	24	wkly	-	-	168
Bauer et al. (2010)	67	Germany	Obesity and weight	40	10.	-	child	y	y	beh	self	y	-	-	y	-	-	-	3	y	rs	36	wkly	f	fix	252
Berkman, Dickenson, Falk, and Lieberman (2011)	84	United States	Smoking	27	46	48	spec	y	n	beh	self	-	-	-	y	mo	yes	-	3	y	rs	168	daily	-	fix	21
Bexelius et al. (2009)	44	Sweden	Medical treatment monitoring	2400	-	-	gen	n	n	beh	self	-	-	-	-	-	-	-	3	y	on	1	once	-	-	1
Bopp et al. (2010)	75	United States	other	54	34.3	65	spec	y	y	exp	self	-	-	y	-	-	-	-	16	y	rs	1	wkly	-	fix	252
Broderick et al. (2012)	87	Australia	Medical treatment monitoring	104	9.5	-	child	y	n	beh	self	-	y	y	-	-	-	-	1	y	rs	52	wkly	t	fix	365
Car, Christen, Hornbuckle, and Moore (2012)	80	Australia	other	72	-	6	prof	y	no	oth	facts	-	-	-	y	-	-	-	5	y	rs	200	daily	-	fix	200
Chen, Chin, Greenberg, Johnstone, and McGuinness (2012)	88	Australia	Pain	24	8.5	33	child	y	n	exp	self	-	-	-	-	-	-	-	1	y	rs	14	daily	-	fix	14

Chib, Wilkin, Ling, Hoefman, and Van Biejma (2012)	20	Uganda	HIV	10000	28	67	gen	n	y	exp	self	-	-	-	-	-	-	-	13	y	on	1	once	-	-	1
Cocco and Tuzzi (2012)	96	Italy	HIV	616	-	51	gen	n	y	exp	self	-	-	-	-	-	-	-	5	-	on	1	once	-	-	1
Conner (n.d.) *	-	New Zealand	other	1200	-	-	-	-	-	-	-	-	-	-	y	-	-	-	5	-	-	52	daily	-	-	13
Conner and Reid (2012)	96	New Zealand	Mood and emotions	162	19.9	59	und	n	n	exp	self	-	-	-	-	cr	yes	-	3	y	rs	-	daily	-	ra	13
Cooper et al. (2011)	82	United Kingdom	Sexual health	51	37	0	-	y	y	exp	self	-	-	y	y	-	-	y	-	-	on	-	once	t	-	1
Curran et al. (2013)	90	Kenya	Sexual health	96	33.3	25	spec	y	y	beh	self	-	-	-	-	-	yes	-	3	-	rs	60	daily	-	fix	60
De Lepper et al. (2013)	83	Uganda	HIV	2164	-	-	gen	n	y	oth	facts	-	-	-	-	gift	-	-	24	y	on	1	once	-	fix	1
De Lepper et al. (2013)	60	Uganda	HIV	3289	-	-	gen	n	y	oth	facts	-	-	-	-	gift	-	-	24	y	on	1	once	-	fix	1
De Niet et al. (2012)	47	Netherlands	Obesity and weight	73	9.8	62	child	y	y	beh	self	y	y	-	-	-	dev	-	3	-	rs	36	wkly	-	fix	270
De Niet et al. (2012)	61	Netherlands	Obesity and weight	73	-	-	spec	n	y	beh	self	-	-	-	y	-	-	-	3	-	-	36	wkly	f	fix	252
Depp et al. (2010)	75	United States	Schizophrenia	8	-	-	spec	y	y	exp	self	-	-	-	-	gift	-	-	-	-	-	252	daily	-	-	84
Devine et al. (2014)	49	United States	Sexual health	96	-	38	spec	y	y	exp	facts	y	-	-	-	-	-	-	1	y	rd	29	-	-	-	30
Dick et al. (2011)	80	United States	Diabetes	18	55	67	spec	y	n	beh	self	y	-	-	-	mo	yes	-	1	y	rs	28	daily	-	fix	28
Donaldson, Fallows, and Morris (2014)	100	United Kingdom	Obesity and weight	17	58.3	59	spec	y	y	beh	self	y	-	y	-	-	-	-	-	-	-	168	wkly	-	-	84
Dowshen, Kuhns, Gray, Lee, and Garofalo (2013)	61	United States	HIV	25	23	8	spec	y	y	beh	self	-	-	-	-	-	-	-	-	y	rs	12	daily	-	-	84
Du et al. (2013)	57	China	Infant feeding	591	25	100	spec	y	n	beh	other	-	-	-	y	-	yes	-	5	y	on	1	once	f	fix	1
Dunstan and Tooth (2012)	93	Australia	Mood and emotions	6	34.3	50	spec	n	n	exp	self	-	-	-	-	-	-	y	1	y	rs	70	daily	-	fix	70
Faghanipour, Hajikazemi, Nikpour, Shariatpanahi, and Hosseini (2013)	38	Tehran	Obesity and weight	80	37.1	100	spec	y	n	oth	self	-	-	-	y	-	-	-	1	y	rs	8	wkly	-	fix	60
Fernandez, Johnson, and Rodebaugh (2013)	74	United States	Depression	24	19	83	und	n	n	exp	self	y	-	-	y	-	-	-	3	y	on	1	once	-	-	-
Ferrer-Roca, Cárdenas, Diaz-Cardama, and Pulido (2004)	26	Spain	Diabetes	23	-	-	-	n	n	beh	self	-	-	-	-	-	-	-	-	-	on	33	once	-	-	33
Gold et al. (2011)	96	Australia	other	158	-	45	spec	n	n	oth	facts	-	-	-	-	gift	-	-	-	-	on	1	once	-	-	1
Gold et al. (2011)	76	Australia	Sexual health	200	-	45	spec	n	y	exp	self	-	-	-	-	-	-	-	-	-	on	1	once	-	-	1
Gonzales, Ang, Murphy, Glik, and Anglin (2014)	-	United States	other	28	20.4	27	spec	y	y	oth	facts	-	-	y	-	gift	-	-	-	y	rs	84	daily	o	ra	84
Gram, Holtermann, Bültmann, Sjøgaard, and Søgaard (2012)	85	Denmark	Pain	67	43.7	0	emp	y	n	exp	self	-	-	-	-	-	-	-	7	y	rs	12	wkly	-	fix	84
Granholm, Ben-Zeev, Link, Bradshaw, and Holden (2012)	86	United States	Schizophrenia	55	48.7	31	spec	y	y	exp	self	-	-	-	-	-	dev	-	-	-	rd	840	daily	-	fix	84
Haberer, Kiwanuka, Nansera, Wilson, and Bangsberg (2010)	24	United States	Medical treatment monitoring	19	34	47	spec	y	n	oth	-	-	-	-	-	-	-	-	1	-	rs	48	daily	-	-	28

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Haller, Sanci, Patton, and Sawyer (2009)	80	Australia	Medical treatment monitoring	520	-	-	spec	y	n	exp	other	-	-	-	-	-	-	-	1	y	on	1	once	-	-	-
Haller et al. (2006)	73	Australia	Medical treatment monitoring	85	-	65	-	y	n	exp	self	-	-	-	y	-	-	-	-	-	on	1	once	-	fix	1
Harris et al. (2010)	43	United States	HIV	107	40.7	21	spec	y	y	beh	self	-	-	-	-	-	-	-	1	y	rs	-	daily	p	-	-
Haug et al. (2008)	66	Germany	Smoking	93	-	-	spec	y	n	beh	self	-	-	-	-	-	-	-	-	-	-	144	wkly	-	fix	84
Holtz and Whitten (2009)	94	United States	Asthma	4	-	-	-	y	n	beh	Self	-	-	y	-	-	-	-	-	-	rs	32	daily	-	fix	32
Horne and Biggs (2011)	-	United Kingdom	Feedback for services	-	-	-	-	n	n	oth	facts	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ingersoll et al. (2014)	67	United States	HIV	19	47.8	58	-	y	y	beh	self	-	-	-	-	-	-	-	1	y	rd	534	daily	-	-	28
Iribarren et al. (2013)	77	Argentina	Medical treatment monitoring	18	33.8	56	spec	y	n	beh	self	-	-	y	-	-	-	-	-	-	-	-	wkly	-	-	-
Irvine et al. (2012)	88	United States	Alcohol	34	-	0	spec	y	n	beh	self	-	-	-	-	-	-	-	-	-	-	9	-	-	-	28
Johansen and Wedderkopp (2010)	-	Denmark	Back pain	260	-	-	spec	y	n	exp	self	-	-	y	-	-	-	-	2	y	rs	53	wkly	t	fix	399
Kazi, Murtaza, Khoja, and Ali (2014)	44	Pakistan	Medical treatment monitoring	840	-	-	gen	n	n	oth	oth	-	-	y	-	-	-	-	2	y	on	1	once	-	-	1
Kew (2010)	100	Malaysia	Medical treatment monitoring	38	-	-	-	n	n	beh	self	-	-	y	-	-	-	y	8	y	-	8	wkly	e	fix	56
Khosropour et al. (2013)	65	United States	HIV	366	-	0	-	y	y	exp	self	-	-	-	-	mo	yes	-	-	-	-	6	mthly	o	-	360
Kibengo et al. (2013)	74	Uganda	HIV	72	33	50	spec	y	y	beh	self	-	-	-	y	gift	dev	-	4	y	rs	-	daily	-	fix	-
Kim, Kim, and Ahn (2006)	-	Korea	Diabetes	45	43.5	58	-	y	n	beh	self	-	-	y	-	-	-	-	4	y	rs	12	wkly	o	-	84
Kolodziejczyk and Norman (2013)	88	United States	Obesity and weight	20	40.1	60	spec	n	y	beh	self	-	-	-	-	-	-	-	-	y	rs	147	daily	t	fix	49
Kongsted and Leboeuf-Yde (2009)	74	Denmark	Back pain	78	-	-	spec	y	n	exp	self	-	-	-	-	-	-	-	3	y	rs	18	wkly	-	fix	126
Kuntsche and Cooper (2010)	89	Switzer-land	Alcohol	55	22.7	67	und	n	y	beh	self	-	-	-	-	gift	-	-	1	y	rs	2	daily	-	fix	2
Kuntsche and Robert (2009)	83	France	Alcohol	70	22.7	67	und	n	y	beh	self	-	-	-	-	-	-	-	2	y	rs	8	-	-	fix	-
L'Engle, Vahdat, Ndakidemi, Lasway, and Zan (2013)	39	Tanzania	Sexual health	4813	-	56	gen	n	y	beh	self	-	-	-	-	-	-	-	3	y	on	1	once	-	fix	1
Lagerros, Sandin, Bexelius, Litton, and Löf (2012)	67	Sweden	Physical activity	171	-	-	gen	n	n	beh	self	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-
Lang (2009)	43	-	Obesity and weight	58	8.7	62	child	n	n	beh	self	-	-	-	-	-	dev	-	3	-	-	112	daily	-	fix	56
Lau, Lau, Chung, Ransdell, and Archer, (2012)	47	China	Physical activity	78	12.8	68	sch	n	n	beh	self	-	-	-	-	gift	-	-	9	y	rs	56	daily	-	-	56
Lee et al. (2013)	67	Singapore	other	78	-	77	spec	y	n	exp	self	-	-	-	-	gift	-	-	23	y	on	1	once	-	fix	1

Lee et al. (2013)	75	Singapore	other	69	-	77	spec	y	n	exp	self	-	-	-	-	gift	-	-	5	y	rs	3	-	-	fix	1
Lewis et al. (2013)	92	United States	HIV	52	38	0	spec	n	n	beh	self	-	-	-	-	-	-	-	-	-	rs	13	wkly	-	fix	90
Li et al. (2013)	28	China	Infant feeding	99	-	-	spec	y	y	beh	other	-	-	-	-	-	-	-	-	-	rs	6	daily	f	fix	6
Lim, Sacks-Davis, Aitken, Hocking, and Hellard (2010)	80	Australia	Sexual health	24	21	69	spec	y	y	beh	self	-	-	-	-	mo	yes	-	5	-	rs	12	wkly	-	fix	84
Macedo, Maher, Latimer, and McAuley (2012)	63	Australia	Back pain	133	-	56	spec	y	n	exp	self	-	-	y	-	-	yes	-	2	y	rs	12	mthly	-	fix	84
Macedo et al. (2012)	97	Australia	Back pain	-	-	56	spec	y	n	exp	self	-	-	y	-	-	yes	-	2	y	rs	12	mthly	t	-	84
Magee, Isakov, Paradise, and Sullivan (2011)	77	United States	other	66	25	75	und	n	n	exp	oth	-	-	-	-	-	-	-	-	-	on	1	once	-	-	1
Malinen, Rönkä, Tolvanen, Sevón, and Jokinen (2014)*	97	-	Mood and emotions	60	-	60	child	y	n	exp	self	-	-	-	-	-	-	-	7	-	rs	7	daily	-	fix	7
Mason, Benotsch, Way, Kim, and Snipes (2014)*	99	United States	Alcohol	18	19.2	55	spec	y	y	exp	self	-	y	-	-	-	-	-	5	-	rd	20	daily	-	fix	4
Mohammed et al. (2012)	57	Pakistan	Medical treatment monitoring	30	-	-	-	n	y	beh	self	-	-	-	-	-	-	-	1	y	rs	90	daily	-	fix	30
Møldrup (2007)	80	Denmark	Smoking	10565	-	-	-	y	n	exp	self	-	-	-	-	-	-	-	2	-	on	1	once	-	-	1
Moore, Crompton, Goozen, et al. (2013)*	86	United Kingdom	Alcohol	82	20.9	49	und	n	n	beh	self	-	-	-	-	gift	yes	-	1	-	-	157	daily	-	fix	157
Moore, Crompton, Goozen, et al. (2013)*	86	United Kingdom	Alcohol	82	22	50	spec	y	y	beh	self	-	-	-	-	gift	yes	-	1	y	rs	157	daily	o	-	157
Mulvaney and Herbold (2013)	-	United States	Appetite	14	-	-	spec	n	n	beh	self	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mutua et al. (2012)	23	Kenya	HIV	72	-	6	spec	y	n	beh	self	-	-	-	-	-	-	-	-	-	-	-	daily	-	-	-
Ostojic et al. (2005)	99	Croatia	Asthma	16	24.6	99	spec	y	n	beh	self	-	-	-	-	-	-	-	-	-	rs	112	daily	-	-	112
Palmier-Claus et al. (2013)	-	United Kingdom	Schizophrenia	24	33	79	spec	y	y	exp	self	-	-	-	-	-	-	-	-	-	rd	24	daily	s	fix	6
Patrick et al. (2009)	-	United States	Obesity and weight	33	47.4	25	spec	y	y	beh	self	-	-	-	-	-	-	-	-	-	rd	336	daily	p	fix	112
Prabhakaran, Chee, Chua, Abisheganaden, and Wong (2010)	82	Singapore	Asthma	60	37	65	spec	y	n	beh	self	-	-	y	-	-	-	-	1	y	rs	14	daily	-	fix	14
Rami, Popow, Horn, Waldhoer, and Schober (2006)	-	Austria	Diabetes	18	16.2	39	spec	y	n	beh	self	-	-	-	-	-	dev	-	-	y	rs	720	daily	t	fix	180
Ranney, M (2014, unpublished) *	77	-	other	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	9	-	-	-	-
Ravert, Calix, and Sullivan (2010)	89	United States	other	16	20.4	88	und	n	n	exp	self	-	-	-	-	mo	yes	-	3	y	rs	14	daily	-	ra	7
Reid et al. (2009)	76	Australia	Mood and emotions	18	15.8	72	und	y	y	exp	self	-	-	-	-	-	-	-	-	-	rs	28	daily	-	-	7

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Rhee, Allen, Mammen, and Swift (2014)	81	United States	Asthma	15	15	40	spec	y	n	beh	self	-	-	y	-	-	-	-	6	-	rd	14	daily	-	fix	14
Riordan, Scarf, and Conner (n.d.)*	-	-	Alcohol	-	-	-	und	n	n	beh	self	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Roberts and Gorman (2009)	70	United Kingdom	Pain	25	-	-	spec	y	n	exp	self	-	-	y	-	-	-	-	-	-	-	-	-	-	-	-
Rinson, (Robinson, Perkins, Bauer, Hammond, & Treasure, 2006)	50	United Kingdom	Eating disorder	21	26	95	spec	y	y	exp	self	-	-	-	-	-	-	-	5	-	rs	-	wkly	p	fix	84
Rönkä, Malinen, Jokinen, and Häkkinen (n.d.)	100	-	Feedback for services	30	-	-	-	n	n	exp	self	-	-	-	-	-	-	-	4	-	on	-	once	-	-	-
Rönkä, Malinen, Kinnunen, Tolvanen, and Lämsä (2010)	87	Finland	other	55	-	-	gen	n	n	exp	self	-	-	y	-	-	-	-	10	y	rs	21	daily	p	fix	7
Rönkä, Malinen, Kinnunen, Tolvanen, and Lämsä (2010)	-	Finland	other	87	-	-	gen	n	n	exp	self	y	-	-	-	-	-	-	10	y	rs	21	daily	p	fix	7
Rubrichi, Battistotti, and Quaglini (2014)	1	Italy	Feedback for services	-	-	-	spec	y	n	exp	oth	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Schembre and Yuen (2011)	74	United States	Appetite	15	20.6	87	gen	n	n	exp	self	-	-	-	-	-	-	-	1	y	rs	12	daily	-	fix	7
Schnall et al. (2013)	90	United States	other	60	-	37	sch	n	n	beh	self	-	-	-	-	-	dev	-	4	y	rs	13	wkly	-	fix	30
Shapiro et al. (2008)	-	-	Obesity and weight	-	-	-	-	n	n	beh	self	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Shapiro et al. (2010)	87	United States	Eating disorder	31	26.3	100	spec	y	y	beh	self	-	-	y	-	-	-	-	4	y	rs	24	daily	f	-	168
Shapiro et al. (2012)	80	United States	Obesity and weight	81	43.1	67	spec	n	n	beh	self	-	-	y	-	mo	yes	-	2	-	rs	4	daily	-	-	360
Shrewsbury et al. (2010)	23	Australia	Obesity and weight	49	-	-	spec	n	n	beh	self	-	-	-	-	-	-	-	-	-	rs	13	mthly	e	fix	360
Smith et al. (2012)	87	United States	other	27	-	0	spec	y	y	exp	self	-	-	y	-	-	-	-	-	-	rs	18	wkly	-	fix	72
Soh (2013)	77	Australia	Medical treatment monitoring	1852	-	100	spec	n	n	exp	self	-	-	-	-	-	-	-	1	y	on	1	once	-	-	1
Song, Foo, and Uy (2008)	86	Singapore	Mood and emotions	100	37.2	50	emp	n	n	exp	self	-	-	-	-	mo	-	-	10	-	-	32	daily	-	-	8
Steinberg, Levine, Askew, Foley, and Bennett (2013)	49	United States	Obesity and weight	26	38.3	100	spec	y	n	beh	self	-	-	-	-	-	-	-	1	y	rs	167	daily	-	fix	167
Struthers, Irvine, and Jackson (2013)	46	United Kingdom	Feedback for services	124	-	-	pro	n	n	oth	oth	-	-	-	-	-	-	-	5	y	-	-	-	-	-	-
Suffoletto, Kristan, Callaway, Kraemer, and Clark (2011)	-	-	Alcohol	26	-	-	spec	n	n	beh	self	-	-	-	-	-	-	-	3	y	rs	12	wkly	-	fix	84
Suffoletto, Callaway, Kristan, Kraemer, and Clark (2012)	82	United States	Alcohol	30	21	64	spec	y	y	beh	self	-	-	y	-	mo	-	-	-	-	rs	-	-	-	-	-
Suffoletto et al. (2013)a	66	United States	Sexual health	23	21	100	spec	y	y	beh	self	-	-	-	-	-	-	-	-	-	rs	12	wkly	-	-	84
Suffoletto et al. (2013)b	74	United States	Medical treatment monitoring	43	30	56	spec	n	n	exp	self	-	-	-	-	mo	-	-	3	-	rs	14	daily	-	fix	14

Swaffield, Jull, and Ampah-Mensah (2013)	71	Ghana	other	175	-	-	pro	y	n	oth	oth	-	-	-	-	-	-	-	2	-	-	2	-	-	-	-
Vahdat, Engle, Plourde, Magaria, and Olawo (2013)	22	Kenya	other	4817	-	61	gen	n	n	oth	self	-	-	-	-	-	-	-	3	-	on	1	once	-	fix	1
Van der Kop, Karanja, Thabane, Marra, and Chung (2012)	69	Kenya	Medical treatment monitoring	273	-	65	-	y	y	exp	self	-	-	-	-	-	-	-	1	-	rs	50	wkly	-	fix	350
Whitford et al. (2012)*	-	United Kingdom	Infant feeding	48	29.7	100	spec	n	n	beh	self	-	-	-	-	-	-	-	1	-	on	1	once	t	-	-
Whitford et al. (2012)*	-	United Kingdom	Infant feeding	68	30.6	100	spec	n	n	beh	self	-	-	-	-	-	-	-	1	-	on	1	once	t	-	-
Whitford et al. (2012)*	80	United Kingdom	Infant feeding	355	-	100	spec	n	n	beh	self	-	-	y	-	-	-	-	1	-	on	1	once	t	-	-
Yun and Arriaga (2013)	86	United States	Asthma	15	26	53	spec	y	n	beh	self	-	-	-	y	mo	-	-	-	-	-	1	daily	-	-	-

Note. * following a citation indicates additional information was provided in personal communication with the author. Shortenings for coding, used in the interests of space, are as follows: spec = specific population; gen = general population; prof= professional population; und = undergraduates; emp = employees; sch = school child; exp =experiential; beh = behavioural; oth = other; cr = credit; mo = money; dev = mobile device provided; wkly= weekly; mnthly = monthly; f = face-to-face; t= telephone; s = smartphone; o = online; p = paper; e = email; fix= fixed schedule; rand=random schedule. Full citations can be found in the supplementary materials.

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Appendix 4: Data collection overlaps

What follows is a matrix displaying the instances where questions were shared across studies (marked with an X). With the exception of demographic information, the same data was not presented twice. However, in the marked instances, questions relevant to one study were asked while collecting data for another. The most notable overlaps are for *Perceived legitimacy of SMS as a psychological research mode* and *Perceptions of privacy and convenience of SMS as a tool for self-report data collection*, as questions regarding legitimacy, privacy and convenience were added to every study possible in order to maximise sample size. Three studies came from the same set of data collected at university of Canberra, but were planned a-priori and addressed different research questions. *Should participants be given a mobile phone, or use their own? Effects of novelty vs utility,* and *Is SMS APPropriate? Comparative properties of SMS and apps for repeated measures data collection* share the same paradigm and participant pool, but analyse different participants (so the data itself is not shared). *Temporal considerations for self-report research using Short Message Service* shares data will *Is SMS APPropriate,* but conducts analyses on different variables and has a substantially different focus.

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
	Chapter 1: Background															
	Chapter 2: How is SMS currently being used for research?															
1	A systematic review of how SMS has been used in the health and psychology literature	-														
	Chapter 3: Are people able, ready and willing to become research participants using SMS?															
2	Assumptions of age and mobile handset type	-	-													
3	Should participants be given a mobile phone, or use their own? Effects of novelty vs utility	-	-	-												
4	Perceived legitimacy of SMS as a psychological research mode	-	-	X	-											
5	Perceptions of privacy and convenience of SMS as a tool for self-report data collection	-	-	X	X	-										
6	A tool for all the ages? SMS as a method for data collection with across a wide age range, an expectancy approach	-	X	-	X	X	-									
7	SMS4Deaf – SMS as a mode for psychology research with the Deaf	-	-	-	-	-	-	-								
	Chapter 4: How should a researcher design an SMS self-report study?															
8	Delay between recruitment and participation impacts on pre-inclusion attrition	-	-	-	-	-	-	-	-							
9	Response rates where SMS is used as a tool for self-report psychological research, a meta-analysis	-	-	-	-	-	-	-	-	-						
10	Temporal considerations for self-report research using Short Message Service	-	-	X	X	X	-	-	-	-	-					
11	As you Likert – cross-mode equivalence of administering lengthy self-report instruments via text message	-	-	-	-	-	-	-	-	-	-	-				
12	Short and sweet? Length and informative content of open-ended responses using SMS as a research mode	-	-	-	X	X	-	-	-	-	-	-	-			
	Chapter 5: How does SMS compare with other tools for data collection?															
13	Is SMS APPropriate? Comparative properties of SMS and apps for repeated measures data collection	-	-	X	X	X	-	-	-	-	X	-	-	-		
14	SMS = Send My Survey: Short Message Service for Longitudinal Research	-	-	-	X	X	X	-	-	-	-	-	-	-	-	
15	Applying cross-language principles to cross-mode measurement invariances	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Chapter 6: Conclusion															